Taxonomy, biodiversity and biogeography of the brittle stars (Echinodermata: Ophiuroidea) of South Africa.

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"The sea, once it casts its spell, holds one in its net of wonder forever"
- Jacques Yves Cousteau

"…echinoderms, a noble group especially designed to puzzle the zoologist".
- Libbie Henrietta Hyman

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CG:	Charles L. Griffiths	FR:	Frank W.E. Rowe	TF:	Toshihiko Fujita

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Signed by candidate

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ABBREVIATIONS

A.L.	Arm length.
AM	Australian Museum, Sydney, Australia.
BMNH	British Museum (Natural History), London, United Kingdom (now NHMUK).
CSIRO	Commonwealth Scientific and Industrial Research Organisation.
DAFF	Department of Agriculture, Forestry and Fisheries, South Africa.
DEA	Department of Environmental Affairs, South Africa.
D.D.	Disc diameter.
D.D./A.L.	Disc diameter to arm length ratio.
EC	Eastern Cape province, South Africa.
EKZNW	Ezemvelo KZN Wildlife, South Africa.
GMNH	Muséum d'Histoire Naturelle (Natural History Museum), Genève, Switzerland (See MHNG)
KZN	KwaZulu-Natal province, South Africa.
MCZ	Museum of Comparative Zoology, Harvard University, Massachusetts, United States of America.
MHNG	Muséum d'Histoire Naturelle (Natural History Museum), Genève, Switzerland (See GMNH).
MNHN	Museum National d'Histoire Naturelle (National Natural History Museum), Paris, France.
MV	National Museum Victoria, Australia (See NMV).
Naturalis	Naturalis Biodiversity Centre, Leiden, The Netherlands (incorporating ZMA: Zoölogisch Museum Amsterdam (Zoological Museum Amsterdam) and RMNH: Rijksmuseum van Natuurlijke Historie (National Museum of Natural History)).
NC	Northern Cape province, South Africa.
NHMUK	Natural History Museum, London, United Kingdom (see BMNH).
NMV	National Museum Victoria, Australia (See MV).
RBINS	Royal Belgian Institute of Natural Sciences, Brussels, Belgium.
RMCA	Royal Museum for Central Africa, Tervuren, Belgium.
RMNH	Rijksmuseum van Natuurlijke Historie (National Museum of Natural History), Leiden, The Netherlands (See Naturalis).
ROV	Remotely Operated underwater Vehicle.
SAEON	South African Environmental Observation Network.
SAMC	Iziko South African Museum, Cape Town, South Africa.
SANBI	South African National Biodiversity Institute.
SAIAB	South African Institute for Aquatic Biodiversity.
SCUBA	Self Contained Underwater Breathing Apparatus.
SEM	Scanning Electron Microscope.
SMNH	Swedish Museum of Natural History, Stockholm, Sweden.
UCT	University of Cape Town, South Africa.
UKZN	University of KwaZulu-Natal, Durban, South Africa.
USNM	Smithsonian Institution, National Museum of Natural History, Washington, D.C., United States of America.
WC	Western Cape province, South Africa.
ZMA	Zoölogisch Museum Amsterdam (Zoological Museum Amsterdam), The Netherlands (See Naturalis).
ZMB	Museum für Naturkunde an der Universität Humbolt zu Berlin (Museum of Natural History at the University of Berlin), Germany.
ZMUC	Natural History Museum of Denmark, Copenhagen, Denmark.
ZSM	Zoologische Staatssammlung München (Zoological State Collection Munich), Munich, Germany.

ABSTRACT

The South African Ophiuroidea were last reviewed by Clark and Courtman-Stock in 1976. In the current investigation, the systematics of the group is thus revised in its entirety for the first time in 40 years. The data used originated from a number of sources. Existing data were sourced from i) published literature, ii) large expeditions or survey data, iii) South African institutional collections and iv) international museums. The majority of new records and data were sourced from previously unidentified specimens deposited in the collections of various South African and international museums and/or institutions, as well as from photographic records and some new, project-specific collecting.

A review is presented of the history of ophiuroid taxonomy in South Africa highlighting the progression of research and of species discovery in the region since 1783. All new records of Ophiuroidea from South Africa since (and including) 1977 are documented, with each species account detailing key references, distribution, ecology and additional remarks. As a result, an additional 28 species are added to the known fauna of the mainland Exclusive Economic Zone of continental South Africa, raising the total known number of ophiuroid species in the region to 136.

The genus *Ophiocoma* Agassiz (Echinodermata: Ophiuroidea: Ophiurida: Ophiocomidae) is reviewed and the number of species in South Africa increased from four to eight. All species are briefly discussed in terms of taxonomy, geographic distribution and ecology. Furthermore, the juveniles of *O. brevipes*, which were found on the ventral side of some adult *Ophiocoma brevipes* specimens, are described in detail. The distribution of the type material of *O. scolopendrina* has led to some confusion, and it is considered appropriate to establish a neotype from the original type locality (Mauritius).

During this study, an 'orphaned' collection of echinoderms housed at the Durban Natural Science Museum, South Africa was rediscovered. The collection included holotypes of the South African endemic ophiuroid *Asteroschema capensis* Mortensen, 1925 [=*Asteromorpha capensis* (Mortensen, 1925) according to Okanishi *et al.*, 2013], the South African endemic asteroid *Anthenoides marleyi* Mortensen, 1925, and *Hacelia superba* var. *capensis* Mortensen, 1925 which were considered lost. The collection was found to include both wet and dry specimens of extant Asteroidea, Ophiuroidea, Echinoidea and Holothuroidea. Furthermore, *Plococidaris verticillata* (Lamarck, 1816) was recorded as a new distribution record for South Africa. Details of these specimens are recorded and the first photographic record of the collection is provided.

The genus *Asteromorpha* Lütken (Echinodermata: Ophiuroidea: Euryalidae: Euryalinae) is revised, and *Asteroschema capensis being* transferred to this genus as a new combination. Consequently, *Asteromorpha* now includes four species: *A. capensis*, *A. koehleri*, *A. rousseaui*, and *A. tenax*. All four species are redescribed and a taxonomic key to the species of the genus *Asteromorpha* is provided.

An identification guide to the Ophiuroidea of South Africa, designed to be comprehensive, illustrated and easy to use for both naturalists and professional biologists, is included. Taxonomic terms, morphological characteristics and technical expressions are defined and described in detail with illustrations to clarify some terminology. The guide includes a taxonomic key to all 136 species, key references, distribution maps, diagnoses, scaled photographs (where possible), and a synthesis of known ecological and depth information.

A review, over time, of six sampling methods for Ophiuroidea collections: trawling, dredging, SCUBA diving, hand-collecting, photographic records and Remotely Operated Vehicles (ROV), is included. Now, trawling and dredging have become less popular sampling methods, with SCUBA diving becoming the most common collection method and photography increasing in popularity.

The depth analysis indicates that the number of species increases with depth until 100m, below which it declines steadily, with the deepest regional ophiuroid (*Ophiura irrorata irrorata*) being recorded at a depth of 3534m. Four exclusively deep-water families (Asteronychidae, Asteroschematidae, Euryalidae and Amphilepididae) are documented.

The highest number of species is recorded on the east coast (110), while the south coast has the lowest number of species (46) and the west coast an intermediate number (55). The rate of change in diversity from west to east is calculated using beta-diversity with the greatest rates of change occurring in known areas of biogeographical delineation. Peaks in the number of records and species generally coincide with major towns, cities, or areas with easy access to the coast.

In terms of biogeographic affinities, 50.4% of the fauna comprises Indo-Pacific species, making up the largest component, followed by the endemic species (24.1%) and those classified as 'other' (13.1%) while Atlantic (7.3%) and cosmopolitan (5.1%) species were the smallest groups.

A total of 33 (24.1%) species are endemic, with 11 being represented inshore (<30m) and 32 offshore (>30m). The highest numbers of endemic species occurs in the Natal ecoregion (25), followed by the Agulhas (18) and Southern Benguela (16) ecoregions, with the lowest number in the Southeast Atlantic (3) ecoregion.

Inshore, 51.6% of species are known from five or less records, with 14.1% recorded from a single record with the maximum number of records for a single species being 171. Offshore, 69.0% of species are known from five or less records and 4.4% from more than 50 records with the maximum number of records for a single species being 95.

A checklist of all species in the region is included, indicating which species are endemic (33 species), have significantly increased their distribution range as a result of this study (23 species), which are recorded here as new to the South African fauna (28 species) and those which have undergone taxonomic revisions (28 species).

As a result of this study, there has been a 20% addition to the Ophiuroidea fauna of the region under discussion, 16% of species showing significant range extensions and 24% of the species being endemic. Attention should now be drawn to resolving taxonomic problems within genera and to understand how South Africa's Ophiuroidea fauna contributes to cryptic diversity, evolution and connectivity on a global scale.

Chapter 1: General Introduction.

Background to Echinodermata and Ophiuroidea

The Echinodermata (from the ancient Greek, ἐχῖνος, ekhinos - meaning spine or hedgehog and δέρμα, derma - meaning skin) is an exclusively marine phylum, belonging to the Deuterostomia branch of the Animal Kingdom. Echinoderms are the only pentamerous or five-rayed organisms. Although they are radially symmetrical, their larvae are bilateral, later developing into radially symmetrical adults. Other unique characters of the echinoderms include their water vascular system: a complex system of channels and reservoirs that form a hydraulic skeleton, their almost hollow interior, dermal endoskeleton and haemal system (Hyman, 1955; Hickman, 1998).

There are approximately 6950 extant and 13000 fossil species of echinoderm (Pawson, 2007). Until recently, published data on echinoderms have been for the southern African region (i.e. south of the Tropic of Capricorn), which included parts of Mozambique, Namibia and South Africa and not within the political boundaries of South Africa *per se*. The number of species recorded globally, for southern Africa and for South Africa are listed in Table 1.1. There are five accepted echinoderm extant classes, with the morphology of each class being quite different (Figure 1.1). The feather stars or sea lilies (Class Crinoidea: Gr. *krinoeidēs,* lily-like) which are either free-living or sessile, have a central body with five or more long, feather-like arms and are the only echinoderm class where the mouth is directed upwards. The sea stars or starfish (Class Asteroidea: Gr. *asteroeidēs,* star-like) have five or more hollow arms radiating from the centre of the body. They are flattened, with a distinctly differentiated dorsal and ventral surface. The sea urchins, heart urchins and sand dollars (Class Echinoidea: Gr. *ekhinos*, spine) have no arms but a single calcareous test which is armed with spines. The sea cucumbers (Class Holothuroidea: Gr. *holothurum*, Gr. *holos*, whole + *thureos*, oblong shield) do not possess arms or spines, and have a more or less cylindrical body that lies on its side with the mouth, which is encircled by feeding tentacles, at one end and the anus at the other. The serpent stars, basket stars and brittle stars (Class Ophiuroidea: Gr. *ophis*, snake + *ura*, tail) have a small disc and long mobile arms; gaining their name from the serpentine-like movements of their arms which have the tendency to break off or autotomise.

Table 1.1. Number of echinoderm species recorded globally, for southern Africa and for South Africa. Global data from Pawson (2007); southern African data from Clark and Courtman-Stock (1976) and Thandar (1989); South African data from Griffiths *et al.* (2010); Filander and Griffiths (2014), Ahmed Thandar and Erich Koch, pers. comm.

Class	**Number of species**		
	Global	***Southern Africa***	***South Africa***
Crinoidea	~650	17	19
Asteroidea	~2 100	99	116
Echinoidea	~800	59	71
Holothuroidea	~1 400	108	143
Ophiuroidea	~2 000	124	119
Total	**~6 950**	**407**	**468**

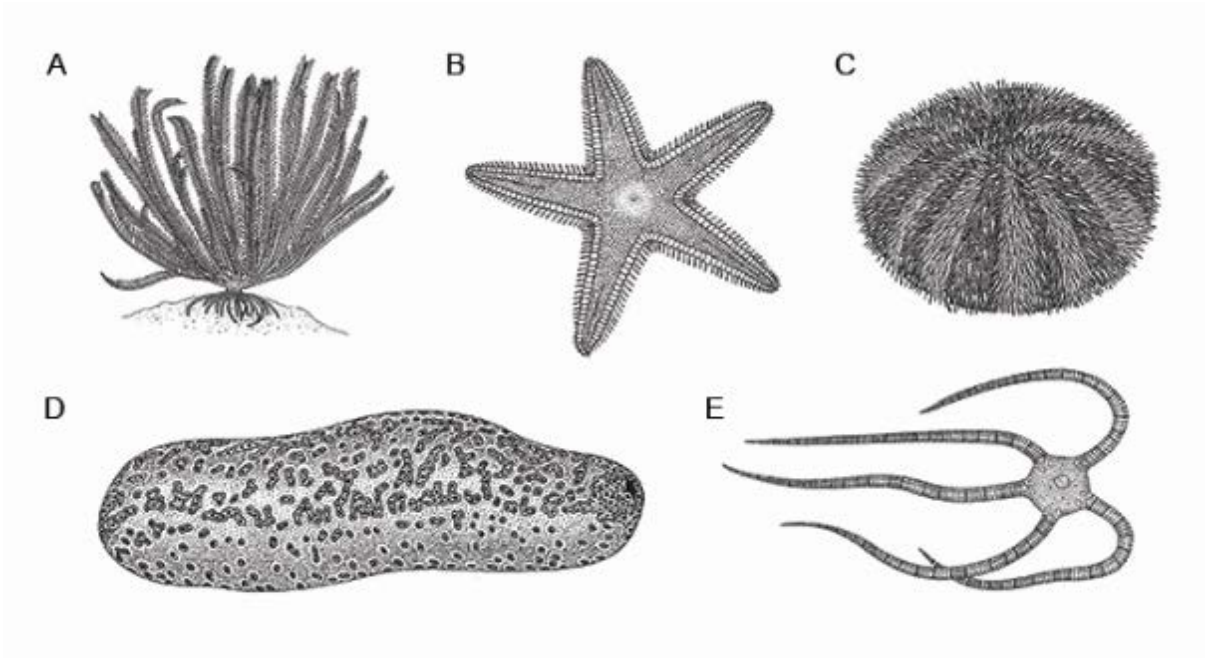

Figure 1.1. Representatives of the five echinoderm classes. A: Crinoidea; B: Asteroidea; C: Echinoidea; D: Holothuroidea; E: Ophiuroidea. Adapted from Rowe and Gates (1995).

General terminology and morphology of Ophiuroidea.

This study is concerned only with the Ophiuroidea, which is the second most diverse echinoderm class globally (Table 1.1). The Ophiuroidea are most similar in body shape to the Asteroidea and can be differentiated from them by a number of features, but most importantly because the arms of an asteroid are usually confluent with one another and the body cavity between the arm and disc is open.

Ophiuroidea are all benthic, but can be found in all types of bottom substrata, at all depths, latitudes and in all oceans and seas. They inhabit secluded habitats and are generally relatively small in size, making them more difficult to collect in comparison to other echinoderm classes, such as the more conspicuous Asteroidea and Echinoidea. Together with their negative response to light (Cowles, 1910) and their high level of stereotropism (Hyman, 1955), they are found in most habitats, concealing themselves by day under stones, rocks, boulders, in sediment or among seaweeds (Hyman, 1955).

The most recent analysis available recognises 2140 valid species as being known globally (Stöhr *et al.*, 2016). At the commencement of this study, there were 14 families and 54 genera of ophiuroids known from Southern Africa, arranged into two orders, the Euryalida and Ophiurida (Table 1.2). The broad differences between the Orders Euryalida and Ophiurida are listed in Table 1.3.

Table 1.2. The number of families, genera and species in each order, as recorded in Clark and Courtman-Stock (1976) for southern Africa.

	Number		
	Euryalida	**Ophiurida**	**Total**
Families	4	10	14
Genera	9	45	54
Species	11	104	115

Table 1.3. Broad morphological differences between the Euryalida and Ophiurida.

Character	**Euryalida**	**Ophiurida**
Covering	Disc and arms covered in thick skin.	Disc and arms covered in scales which may be concealed by skin, granules and / or armament.
Arm attachment	Ventrally.	Most often laterally.
Arms	Branched or simple.	Simple.
Arm spines	Reduced or minimal in number; attached ventrolaterally.	One to many; attached laterally.
Example	*Astroglymma* cf. *sculptum* (scale bar: 20mm) 	*Ophiocoma dentata* (scale bar: 20mm) 
	Asteroschema salix (scale bar: 10mm) 	*Ophiolycus dentatus* (scale bar: 10mm) 

Most Ophiuroidea can be identified to species level based on external morphology. In the ophiuroids, the arms and disc are sharply set off from one another and the organs, in most cases, are restricted to the disc. The disc can be round or pentagonal, flat or puffy, excavated or indented radially or interradially. The disc may be covered with skin, scales, spines, granules, stumps, or a combination of these. There are usually five arms, but sometimes more, and these can be long and slender, short and stout and may be smooth or spiny. While the majority of species have simple arms, basket stars have branching arms, producing a network of tree-like branches.

To the eye, the ophiuroid arms appear to be jointed, but these 'joints' correspond to internal vertebrae and are usually covered dorsally, ventrally and laterally by arm plates. Most often the lateral arm plates bear arm spines, varying in number from 1-15 forming a vertical series. The arm spines may be positioned at right angles, or they can be appressed to the arm. The arm spines can also vary in length

and may be pointed, blunt, clavate, hooked or bifurcate. In addition, the spines can be smooth, serrated, or host hooks to varying degrees. See *Glossary* (Appendix A) for clarity of terms.

In contrast to other echinoderms, the Ophiuroidea lack ambulacra or ambulacral grooves on the body surface. A pair of tube feet or tentacles are present on each arm joint on the ventral surface, which in many cases are protected by one or more modified spines called tentacle scales.

In general, the genital slits occur ventrally. They extend from the disc margin to the oral shields, supported either side by an elongated genital plate. These plates may be distinct, but the shield adjacent to the arm base is usually indistinct. The genital slit edges may be smooth, have scallops, or host genital papillae. Externally, these slits may be long and narrow, short and wide, or occur in pairs, which may or may not be divided.

The primary characters by which most families are distinguished from each other are located on the jaws. Jaw features include the oral papillae, dental papillae, oral tentacle pores, oral tentacle scales, teeth, oral shields (which are plates covering the greater area of the jaws) and adoral shields, which flank the oral shields on either side. In combination with the jaws, the arrangement, number, shape and size of various other external characters determine genera and species.

In order to identify Ophiuroidea, knowledge of the terminology used in scientific descriptions is necessary. Illustrations in this chapter are of broad morphological characters and are supplemented in a glossary (Appendix A).

The main taxonomic characters on the dorsal disc are the radial shields (Figure 1.2) and the primary scales or primary rosette, including the central scale, which may or may not be distinct (Figure 1.3). The armament of the dorsal disc is also of prime importance and may include granules, spines, tubercles or scales, which may or may not be similar within families or species. On the dorsal arms, the dorsal arm plates and, if present, the arm combs (Figure 1.2) are taxonomically significant. Figure 1.2 shows some of the dorsal characters and a composite of some typical family dorsal disc armament.

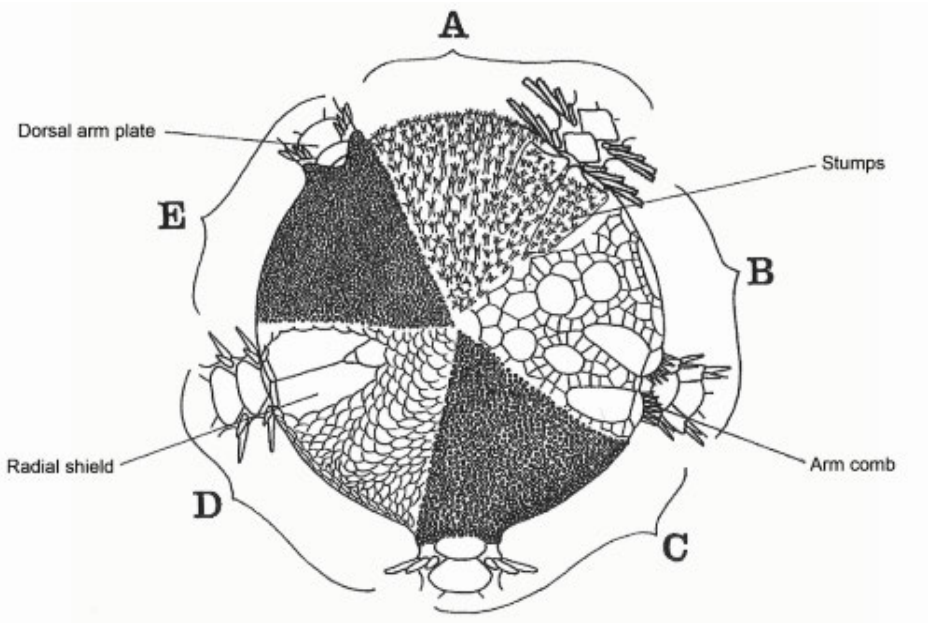

Figure 1.2. Composite diagram showing characters of the dorsal surface of the disc in the following families, A) Ophiotrichidae, B) Ophiuridae, C) Ophiocomidae, D) Amphiuridae and E) Ophiodermatidae. Adapted from Clark and Rowe (1971).

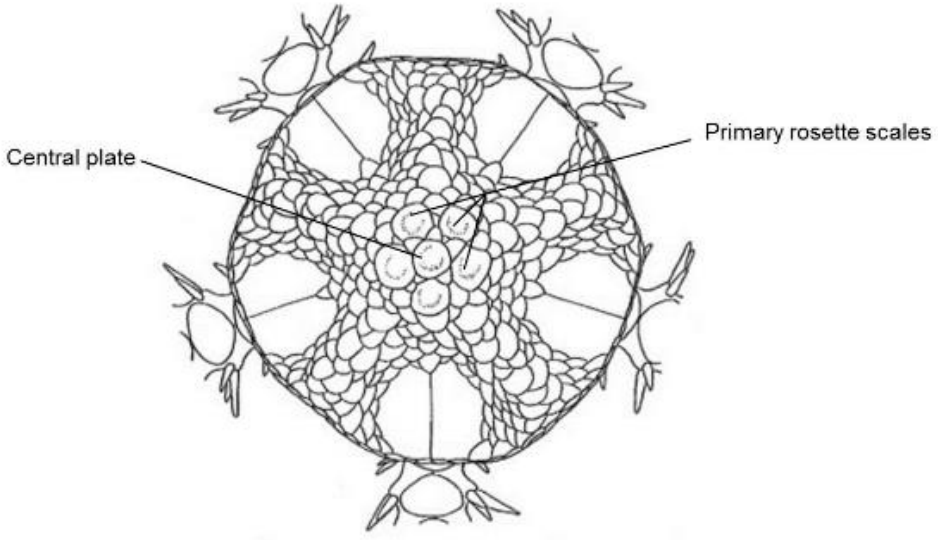

Figure 1.3. Scales forming part of the primary rosette including the central plate. Adapted from Clark and Rowe (1971).

The ventral surface of the disc (Figure 1.4) is more complex and, apart from the jaws, the main characters visible are the genital slits and genital papillae, while the ventral arms are dominated by the ventral arm plates, lateral arms plates, tentacle scales, tentacle pores and arm spines. The interradial areas may also be covered in a combination of granules, spines, tubercles and scales. Figure 1.4 shows the main ventral characters and a composite of some typical family ventral disc armament.

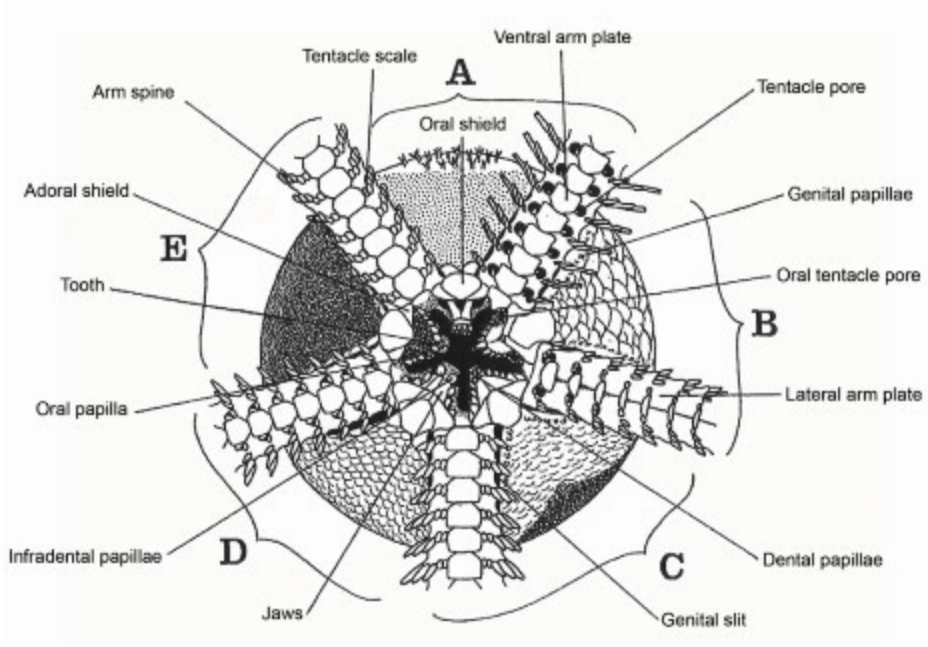

Figure 1.4. Composite diagram showing characters of the ventral surface of the disc in the following families, A) Ophiotrichidae, B) Ophiuridae, C) Ophiocomidae, D) Amphiuridae and E) Ophiodermatidae. Adapted from Clark and Rowe (1971).

As explained above, the combination of jaw characters are unique to most Ophiuroidea families. Table 1.4 illustrates the position and arrangement of the oral papillae, dental papillae, oral tentacle pores, oral tentacle scales, teeth, oral shields and adoral shields in 15 Ophiuroidea families where the differences are most obvious.

Table 1.4. Representative jaws and key features of South African Ophiuroidea families. Papillae and teeth are colour coded: Yellow: infradental papillae, blue: apical papillae, green: oral papillae, purple: dental papillae, orange: teeth, pink: oral tentacle scales. Illustrations adapted from Mortensen (1933c), Clark and Rowe (1971) and Clark and Courtman-Stock (1976).

Gorgonocephalidae & Asteronychidae Jaws armed with more or less, spiniform oral papillae (green). 	**Euryalidae& Asteroschematidae** Apical papillae (blue) and sometimes some papillae (green) either side which may or may not be considered as true oral papillae. 	**Ophiomyxidae** Both teeth (orange) and oral papillae (green) serrated, may be broad or narrow and appear similar. Oral papillae either side of jaws, teeth apical. 

Amphiuridae & Amphilepididae Jaws host two infradental papillae (yellow) spaced apart and symmetrical, teeth (orange) may be broad or tapering and flanked by one, two or three oral papillae (green) either side. There may also be an oral tentacle scale inserted into oral slit. 	**Ophiactidae** Single, apical, broad and blunt papillae (blue) and broad, rounded or rectangular teeth (orange) with a diastema between one or two oral papillae (green). Within the diastema, an elongated oral tentacle scale can sometimes be seen, deep in the mouth. 	**Ophiocomidae** Teeth broad and square (not illustrated here) with a number of dental papillae (purple) and oral papillae (green) present. 	**Ophionereididae** Broad quadrangular teeth or teeth with blunt angled apices (orange). The four or more oral papillae (green) may be in series or overlap the tentacle scale of second oral pore. 

Ophiotrichidae Cluster of dental papillae (purple) superficial to the broad rectangular teeth (not illustrated here) and no oral papillae present leaving oral tentacle scale exposed. 	**Ophiuridae** Numerous oral papillae (green and blue) with papillae (pink) both sides of second oral tentacle pore, often within series. 	**Ophiacanthidae** Single pointed apical papilla (blue) flanked by three or more oral papillae (green), often with distalmost papillae being enlarged. Teeth below apical papillae (orange). 	**Ophiodermatidae** Jaws covered in granulation, teeth (orange) not particularly broad, oral papillae (green) in a vertical series down sides of the jaw and in series with oral tentacle scale (pink) placed towards the distal end. 	**Ophiolepididae** Rounded oral papillae each side of jaw (green) with distalmost being broadest and in series with single curved tentacle scale (pink). Sometimes apical oral papillae present (blue). 

Aims and objectives

The Ophiuroidea in southern Africa have been relatively well-documented (Clark, 1923; Mortensen, 1925; Mortensen, 1933c; Clark, A.M., 1952; Clark, 1974; Clark and Courtman-Stock, 1976; Clark, 1977; Thandar, 1989; Griffiths *et al.*, 2010; Olbers and Samyn, 2012). However, the existing monographic treatments are largely out-dated and are not confined to South Africa, making a clear assessment of the South African fauna challenging. In addition, the available identification keys compiled by Clark and Courtman-Stock (1976) lack images of many species and are riddled with jargon too technical for most users to understand. Furthermore, since the publication of Clark and Courtman-Stock (1976), an extensive number of samples have been collected and have accumulated unidentified in the collections of the Iziko South African Museum. It is the examination of these accumulated unidentified collections which forms the principal basis for this study.

The main objective of this study was to revise the taxonomy, biodiversity and biogeography of the Ophiuroidea or brittle stars of South Africa. This objective has been achieved through the examination of existing ophiuroid material, identifying unidentified material from various museum and institutional collections, completing an analysis of the biogeography of the fauna and creation of a modern, well-illustrated and easy to use taxonomic key and guide to regional species.

To achieve the main objective, the work plan was to:

- Examine existing ophiuroid material in museums which hold regional fauna i.e. the Iziko South African Museum (Cape Town, South Africa), the Durban Natural Science Museum (Durban, South Africa), the Royal Museum for Central Africa (Tervuren, Belgium) and the Royal Belgian Institute of Natural Sciences (Brussels, Belgium);
- Examine and identify unidentified collected material, i.e. samples from various surveys and sources e.g. ACEP cruises, private collections, Iziko South African Museum;
- Examine existing museum material from the KwaZulu-Natal (KZN) coast from the intertidal and subtidal zones, collected on SCUBA and by hand since the late 1990's as a result of the South African / Belgian collaboration on echinoderms and algae;
- Elucidate the biogeographic patterns, species richness and endemism using GIS technology and available marine biogeographic data;
- Produce a revised species checklist, adding new species or records and resolving any taxonomic uncertainties relating to previously-recorded species;
- Produce a taxonomic key for species found in South Africa; and
- Produce an identification guide to the regional fauna, supported by diagnoses, distribution maps, ecological or habitat information and photographic images for each species.

Outline of chapters

The above aims and objectives are achieved by presenting findings in the various chapters listed below. Each of these Chapters (except Chapters 1 and 8) have been prepared as manuscripts for submission to various journals. Thus some repetition, for example in the introductions of the various chapters and some species accounts, was inevitable and formatting differences were unavoidable, but these have been minimised as far as possible.

The component chapters included in the thesis are as follows:

Chapter 1: General Introduction.
This chapter provides background information about the Ophiuroidea as a group and the basic terminology used in Ophiuroidea identification and taxonomy. Additional technical terms and morphological characteristics are defined in Appendix A (glossary).

Chapter 2: New or notable records of brittle stars (Echinodermata: Ophiuroidea) from South Africa.
This chapter outlines the history of Ophiuroidea taxonomy and research in South Africa since 1783. It documents species which have been added to the South African fauna since the last major monograph in 1976, as well as a number of species that have undergone taxonomic revisions, or for which noteworthy discoveries have been made regarding type material. This chapter was prepared as a manuscript for publication in the journal *African Natural History*.

Chapter 3: The Ophiocoma species (Ophiurida: Ophiocomidae) of South Africa.
During the course of the study, it became apparent that there were many common *Ophiocoma* species that were not included in the South African faunal checklist. The Ophiocomidae is known to be a challenging family to identify, but is abundant in the Indo-Pacific. This chapter was aimed to clarify the diagnostic characters of species within this family and to add four additional *Ophiocoma* species to the fauna, all of which are common in KwaZulu-Natal. This chapter was prepared as a manuscript published in the *Western Indian Ocean Journal of Marine Science*.

Chapter 4: The rediscovery of a collection of echinoderms, including two holotypes - in the Durban Natural Science Museum, South Africa.
During an investigation into which museums, in addition to the Iziko South African Museum, housed Ophiuroidea material within South Africa, a small echinoderm collection was rediscovered in Durban. In this collection, some material deposited by Jeffrey Bell and Theodore Mortensen, two leaders in echinoderm taxonomy in the early 20th century, were located. The significance of this rediscovery is highlighted in this chapter, where two holotypes were found. This chapter was prepared as a manuscript published in the *Durban Natural Science Museum Journal, Novitates*.

Chapter 5: A taxonomic review of the genus Asteromorpha Lütken (Echinodermata: Ophiuroidea: Euryalidae).
The significance of the echinoderm collection rediscovered in the Durban Natural Science Museum was soon communicated to echinoderm taxonomists around the world, including the rediscovery of the holotype of *Asteroschema capensis* Mortensen 1933, which was thought to be lost. Together with Japanese taxonomists, a revision of the genus *Asteromorpha* was undertaken and a new combination, *Asteroschema capensis* (Euryalidae: Asteroschematidae) and the genus *Asteromorpha* was revised. As a consequence, the genus *Asteromorpha* now includes four species. These species were redescribed and a taxonomic key to all species of the genus *Asteromorpha* provided. This chapter was prepared as a manuscript published in *The Raffles Bulletin*.

Chapter 6: Identification guide of the revised South African Ophiuroidea.
This chapter is aimed at presenting an easy to use guide to the identification of South African Ophiuroidea. This guide is designed to be comprehensive enough for scientists to obtain accurate and useful information, while easy enough for a naturalist to understand. The morphological characters referred to are supplemented by a glossary in Appendix A. Information for each species includes

taxonomic synonymies, diagnostic features, distribution (including maps), depth range, known habitat and any additional remarks that are considered noteworthy. Each species is represented by at least one photograph or illustration.

Chapter 7: Biogeography and biodiversity of South African brittle stars (Ophiuroidea: Echinodermata).

A comprehensive analysis of the diversity, distribution and depth patterns, species richness, faunistic affinities, endemism and spatial patterns is presented here. The distribution data from the inshore (<30m) and offshore (>30m) components were separated. In addition to this, the sampling effort and sampling methods used in South Africa from 1873 to 2013 were analysed.

Chapter 8: Synthesis.

A synopsis of the findings and significance of the research documented during this study is collated in this short section, followed by a list of literature cited.

Chapter 2: New or notable records of brittle stars (Echinodermata: Ophiuroidea) from South Africa.

ABSTRACT

Ophiuroid research in South Africa has not kept pace with global taxonomic research with the last major taxonomic review of the group being published in 1976. The current chapter documents all new records of Ophiuroidea from South Africa since (and including) 1977. These records originate from specimens housed in five zoological collections, from photographic records and from reports published in the non-taxonomic literature. A short review of the history of ophiuroid taxonomy in South Africa is also given and for each new record, key references, distribution, ecology, additional notes and, where possible, photographs, are presented. This has resulted in an additional 24 species being recorded within the mainland Exclusive Economic Zone of South Africa, elevating the total known number of ophiuroid species reported in the region to 136.

INTRODUCTION

The coastline of mainland South Africa is *c.* 3650km in length, with an Exclusive Economic Zone (EEZ) of 1 068 659km^2 (Griffiths *et al.*, 2010). The greatest depth recorded within the mainland EEZ is *c.* 5700m. The continental shelf is narrow along the east coast, wider on the west coast and reaches a maximum width of *c.* 260km off the Agulhas Bank in the south. Marine systematic research in South Africa began during the mid-1750s to late 1800s (Clark, 1923) and initially took the form of a number of large expeditions, such as the *Challenger* and the *Gazelle* expeditions that collected within South African waters. The majority of these specimens were taken to European museums, where they were described and often well illustrated (Linder and Griffiths, 1999; Griffiths *et al.*, 2010). In the 20th century, further efforts to document the southern African echinoderm fauna were undertaken by other large expeditions, such as the *Valdivia* and some Antarctic expeditions (Clark, 1923). Today, South Africa is well-known for its extraordinary biodiversity and is considered to be the third most biologically diverse country in the world (Van den Berg, 2008). Griffiths *et al.* (2010) reported that 12 914 marine species were known from South Africa, with 33% of these endemic to the region. Complementing this, over 291 000 records, including marine invertebrates, molluscs, fish and algae are curated at various coastal museums within South Africa alone (Griffiths *et al.*, 2010).

The current state of knowledge for ophiuroids in South Africa is a result of contributions from a number of authors since the late 1700s (Figure 2.1). The first record of an ophiuroid from South Africa was that by Retzius (1783) who reported *Asterias euryale* (=*Astrocladus euryale*) from the Cape of Good Hope, followed by Müller and Troschel (1842) and Ljungman (1867b) who added two and five additional species to the South African fauna, respectively. As a result of the *Challenger* expedition, which sampled seven stations within South African waters (excluding the Prince Edward and Marion Islands), Lyman (1878) and Lyman (1882) reported four and 17 new ophiuroids, respectively. Later, Bell (1888) described one additional new ophiuroid from the same collection. Bell (1905) further added five new ophiuroids in one of his papers on the Echinodermata of South Africa. Döderlein (1910) wrote the first consolidated account of South African echinoderms, reporting 84 species of echinoderm, including 29 ophiuroids.

More than a decade later, Clark (1923) reported a total of 57 ophiuroid species as being known for South Africa, including six new species, which were largely derived from the *Pieter Faure* expedition. Mortensen (1925) added two more species to the fauna from a collection sent to him from the Durban Museum (*Astroschema capense* (=*Asteromorpha capensis*) and *Ophiactis savignyi* (Müller and Troschel,

1842)), the former being new to science. Hertz (1927a; 1927b) added four new species to the South African fauna, but two of these were soon synonymised by Mortensen (1933c) in his significant contribution to the Ophiuroidea and Asteroidea of South Africa. Mortensen (1933c) recorded 36 new ophiuroid species from material collected mostly by the *Pickle* and the *John. C. Meikle*, bringing the total number of ophiuroids known for South Africa to 82 species. Mortensen (1936) reported on collections from the *Discovery* expedition and added two new species from South Africa. Clark, A.M. (1952) described an additional three species collected during the University of Cape Town (UCT) Ecological Surveys and from the *Africana*. Later, Clark (1974) summarised records from 22 years of collections undertaken during the UCT Ecological Surveys and the *Anton Bruun* expedition that had accumulated since the Clark, A.M. (1952) report, describing three new species and adding four new records to South Africa. Clark and Courtman-Stock (1976), now the standard monograph on the southern African echinoderm fauna (excluding Holothuroidea), reported on 115 species of Ophiuroidea. However, only 101 of these species were found within the political borders of South Africa. Shortly afterwards, Clark (1977) reported on a number of deep-water species collected by the *Meiring Naude*, which added ten new ophiuroid species to the South African fauna. Madsen (1977) reported *Ophiernus quadrispinus* Koehler, 1907 from off Cape Point, a new record for South Africa. Following this, no taxonomic work was undertaken for 35 years until recently when Olbers and Samyn (2012) reported *Ophiocoma brevipes* Peters, 1851, *O. dentata* Müller and Troschel, 1842, *O. doederleini* De Loriol, 1899 and *O. pusilla* (Brock, 1888) as new records for South Africa. Later that year, Milne (2012) reported *Ophiactis picteti* (De Loriol, 1893b), *Macrophiothrix demessa* (Lyman, 1862) and *M. propinqua* (Lyman, 1862) occurring at Sodwana Bay. These two reports raised the total number of ophiuroids reported in the published literature for South Africa to 119.

In addition to these published reports, additional data and unidentified material have continued to accumulate. Bolton *et al.* (2001) reported that between 1999 and 2001, 51 species of echinoderm were added to the KwaZulu-Natal (KZN) checklist. The voucher specimens supporting these records have been deposited in the collections of the Royal Museum for Central Africa in Tervuren, Belgium (RMCA) and although Samyn and Thandar (2003) used these records to conduct a preliminary biogeographical analysis, no species list was ever formally published. In addition, ophiuroid samples have continued to accumulate in the Iziko South African Museum (SAMC) but have remained unidentified and mostly uncatalogued for a period of ~35 years.

The aim of the present contribution is to gather all data regarding additions to the ophiuroid fauna of South Africa subsequent to the previous monograph by Clark and Courtman-Stock (1976), and to list and document these in a single publication. These new records include both those published in papers subsequent to 1976 (as listed above), the identified but unpublished records of RMCA, photographic records and those newly identified by the author from collections in the SAMC.

MATERIALS AND METHODS

The ophiuroid species reported on in this account originate from a number of sources. The majority of the records are from unidentified specimens deposited in the SAMC collection, while others originate from the Ezemvelo KZN Wildlife (EKZNW) echinoderm collection, housed in Durban. Also reported on are the South African specimens housed in the RMCA in Tervuren, Belgium, the Smithsonian National Museum of Natural History, Washington DC (USNM), and the Australian Museum (AM) in Sydney. Additional records were obtained from photographic evidence sourced from the South African National Biodiversity Institute (SANBI) iSpot programme, the Animal Demography Unit EchinoMAP programme and published literature, as cited in the taxonomic account below.

Specimens are preserved either in 70% ethanol or dry. The RMCA collections are preserved dry, while those held by SAMC and EKZNW are mostly preserved in ethanol. The specimens were collected using a variety of methods, including trawling, dredging, grab sampling, SCUBA diving and by hand on the shore. The depths at which the specimens were collected ranged from 0-2 948m.

Specimens were primarily identified using the keys and descriptions of Lyman (1878), Clark, A.M. (1952), Clark and Rowe (1971), Clark (1974), Clark and Courtman-Stock (1976), Cherbonnier and Guille (1978), Mortensen (1925) and Mortensen (1933c). Additional useful literature is also cited for each species.

Taxa are arranged according to their currently known classification, as given by Stöhr *et al.*, 2014 in the World Ophiuroid Database linked to the World Register of Marine Species (WoRMS). Species are presented under the binomen as considered valid by Stöhr *et al.*, 2014. A comprehensive diagnosis is given and where possible, type material, distribution, ecology and additional notes are also reported. In addition, where specimens were available, these were photographed.

RESULTS

Species accumulation over time

The increasing number of ophiuroid species reported for the region since 1783 is presented in Figure 2.1. For more than 60 years, only a single species was known for the region. The number of species slowly increased until 1923, when there were a number of reports by largely three European researchers whose work focused on South African echinoderm collections over approximately the following half century, culminating in the monograph of Clark and Courtman-Stock (1976). From that time until the start of the present study, no ophiuroid taxonomy has been undertaken in South Africa.

This report documents additions to the ophiuroid fauna since Clark and Courtman-Stock (1976), including Clark (1977) and Madsen (1977), raising the total by 24 species across 11 families and 19 genera. Therefore, the current total number of known species from South Africa is 136.

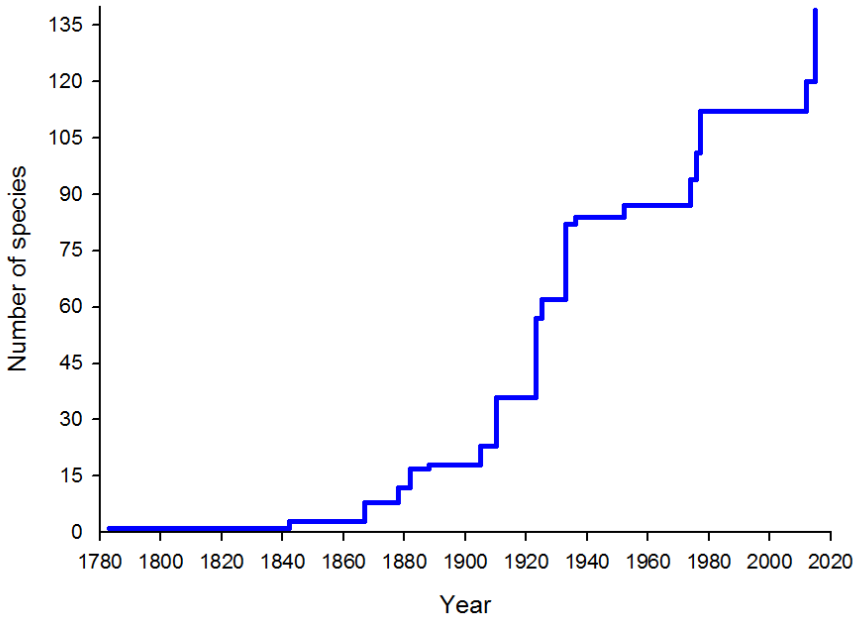

Figure 2.1. Increase in the number of Ophiuroidea species reported for South Africa from 1783 to present (136).

Of the 28 species reported here, 24 are new to South Africa, and comments are made on a further four (*Amphilimna cribriformis* Clark, 1974; *Ophionephthys lowelli* Clark, 1974; *Ophiernus quadrispinus* Koehler, 1908a; *Amphioplus* (*Lymanella*) *depressus* (Ljungman, 1867b)). Six species are represented by only a single record, while 11 have been reported five or more times. Twelve species were recorded in only shallow-water (<30m), four in deep-water (31-500m), five in very deep-water (>501m), while seven species traversed both shallow and deep depths. Most of the additions are Indo-Pacific species whose ranges have been extended southwards into subtropical eastern regions of South Africa and were derived from the collection deposited in the RMCA and unidentified material in the SAM. Table 2.1 lists all species with their global and local distribution and depth ranges within South Africa.

Table 2.1. Summary of distribution and depth information of new or notable records of ophiuroid species for South Africa presented in this chapter. Notable species are marked with an asterisk. WC: Western Cape, EC: Eastern Cape and KZN: KwaZulu-Natal.

Family and species	Distribution (within South Africa)	Depth (within South Africa)	Global Distribution
Asteroschematidae			
Asteroschema salix	Off Glenmore (KZN)	900m	New Zealand.
Gorgonocephalidae			
Astroboa nuda	Sodwana Bay (KZN)	68-120m	Indo-Pacific, Western Indian Ocean, Mozambique, Madagascar, Red Sea, East Indies, China and south Japan, Persian Gulf, Philippines, Australia.
Astroglymma cf. *sculptum*	Off Umhlali (KZN)	68-70m	Indo-West Pacific, Mauritius, Malaysian Archipelago, India, China, Australia.
Ophiomyxidae			
Ophiomyxa australis	Mbashe River (EC) to Dog Point (KZN)	11-75m	East Africa and Islands, Western Indian Ocean, Madagascar, Kenya, Somalia, Tanzania, Red Sea, Seychelles, Mascarene Basin, New Zealand.
Ophiuridae			
*Ophiernus quadrispinus**	Off Cape Town (WC)	2 730-2 948m	South Georgia and Crozet Island, Southern Ocean, southern Atlantic, near the South Orkneys.
Amphiophiura sculptilis	Off Durban (KZN)	2 608m	Northern Atlantic, southern Atlantic, Antarctic Ocean, Zanzibar, Reunion, Indonesia, Japan, Oman, south America, Brazil, Bay of Bengal.
Amphiuridae			
*Amphilimna cribriformis**	Umhlali (KZN) to Prince's Grant (KZN)	38-200m	Mozambique.
*Amphioplus (Lymanella) depressus**	Durban (KZN) to Sodwana Bay (KZN)	0m	Arabian Sea, Persian Gulf, Bay of Bengal, Red Sea, Madagascar, Mozambique, Australia.
*Ophionephthys lowelli**	East London (EC) to Sodwana Bay (KZN)	0-55m	None (endemic).
Ophiactidae			
Ophiactis cf. *picteti*	Trafalgar (KZN) to Sodwana Bay (KZN)	7.5m-25m	Madagascar, Kenya and Tanzania, Western Indian Ocean, East Indies, Indo-Malayan Region, Australia.

Ophiocomidae			
Ophiocomella sexradia	Reunion Rocks (KZN)	0m	Indo-Pacific, Mozambique, Reunion, Rodrigues, India, south Japan, China, Australia, Tasman Sea, Hawaiian Islands.
Ophiomastix koehleri	Aliwal Shoal (KZN) to Sodwana Bay (KZN)	14-15m	Madagascar, Zanzibar, Kenya, Aldabra, Comoros.
Ophiomastix venosa	Coffee Bay (EC) to Sodwana Bay (KZN)	15-21m	Tropical Indo-Pacific, Mozambique, Aldabra, Kenya, Madagascar, Mascarene Basin, Rodriguez, Seychelles, Somalia, Tanzania, Philippines, Comoros, Bay of Bengal.
Ophiotrichidae			
Macrophiothrix demessa	Aliwal Shoal (KZN) to Bhanga Nek (KZN)	13-64m	Tropical Indo-West Pacific, Mozambique, Mauritius, Zanzibar, Red Sea, India, Seychelles, Maldive Islands, Philippines, China Sea, Australia, Hawaiian Islands.
Macrophiothrix propinqua	Aliwal Shoal (KZN) to Kosi Bay (KZN)	7.5-50m	Tropical Indo-West Pacific, Western Indian Ocean, Mozambique, Madagascar, Kenya, Tanzania, Somalia, Red Sea, India, Aldabra, Comoros, Mascarene Basin, Mauritius, Red Sea, Seychelles.
Ophiothrix (Acanthophiothrix) purpurea	Sodwana Bay (KZN) to Kosi Bay (KZN)	12-29m	Western Indian Ocean, Tanzania, Aldabra, Madagascar, Mascarene Basin, Red Sea, Seychelles, Australia.
Ophiothrix (Ophiothrix) echinotecta	Isipingo (KZN) to Bhanga Nek (KZN).	0-64m	Mozambique, Madagascar, Kenya, Tanzania, Somalia.
Ophiothrix (Ophiothrix) foveolata	Amanzimtoti (KZN) to Sodwana Bay (KZN)	9-305m	Mozambique, Madagascar, Thailand.
Ophiacanthidae			
Ophiotoma cf. *alberti*	Cape Town (WC)	2 730m	Rockall Trough, Bay of Biscay, Azores, north eastern Atlantic.
Ophiotoma cf. *gracilis*	Cape Town (WC)	2 875-2 948m	Lesser Antilles and Columbia.
Ophiodermatidae			
Ophiochaeta hirsuta	Sodwana Bay (KZN) to Kosi Bay (KZN)	8-29m	Indo-Malayan Region, Western Indian Ocean, Red Sea, Aldabra, Australia, South Pacific Islands.
Ophioconis cupida	Kosi Bay (KZN)	49m	Comoros, Madagascar, Red Sea, Bay of Bengal, China, Japan, Philippines, Australia, Pacific Islands.
Ophiodyscrita acosmeta	Sodwana Bay (KZN)	16-23m	Japan, China and Australia.
Ophiopeza spinosa	Leadsman Shoal (KZN) to Kosi Bay (KZN)	8-24m	Western Indian Ocean, Mozambique, Kenya, Madagascar, Mauritius, Tanzania, Seychelles, Somalia, Aldabra, Mascarene Basin, Red Sea, South East Polynesia, Hawaii.

Ophiarachna affinis	Sodwana Bay (KZN)	14-31m	Mozambique, Aldabra, Seychelles, Red Sea in East Indies, Indonesia, Australia, Fiji, Samoa, Philippines and south Pacific Islands.
Ophiarachnella gorgonia	Aliwal Shoal (KZN) to Bhanga Nek (KZN)	8-20m	Islands of the Western Indian Ocean, Somalia, Tanzania, Kenya, Madagascar, Mozambique, Mascarene Islands, Red Sea, Mauritius, East Indies, China, Japan, Ceylon, Bay of Bengal, Thailand, Philippines, South Pacific Islands, Australia.
Ophiarachnella septemspinosa	Protea Banks (KZN) to Bhanga Nek (KZN)	8-44m	Western Indian Ocean, Mozambique, Kenya, Madagascar, Tanzania, Red Sea, Mauritius, Seychelles, Aldabra, Mascarene Basin, Maldives, East Indies, China and South Japan, Australia, Philippine Islands.
Ophiolepididae			
Ophioplocus imbricatus	Sodwana Bay (KZN)	10m	Mozambique, Mauritius, Madagascar, Reunion, Kenya, Tanzania, Somalia, Red Sea, Seychelles, Aldabra, Mascarene Basin, Andaman Sea, Australia, New Zealand.

TAXONOMIC ACCOUNT

Class OPHIUROIDEA Gray, 1840
Family ASTEROSCHEMATIDAE Verrill, 1899

Asteroschema salix Lyman, 1879
(Plate 2.1A, B)

Asteroschema salix Lyman, 1879: 66-67, pl. 17, figs 466-469; Baker, 1980: 23-24; McKnight, 2000: 21, 22. pl. 6, fig. 7.

Material / Records

SAMC A28143, -31.0000°, 30.4500°, off Glenmore, depth 900m, 12 May 1977, *Meiring Naude*, station number SM134, beam trawl, identified by M. Okanishi and J.M. Olbers.

Diagnosis *(See Baker, 1980)*

D.D. up to 10mm. Disc round, indented interradially, lateral interradial surface almost vertical, body surface covered with epidermal plates with rounded granules (*c.* 100µm long and 80µm thick on periphery and *c.* 70µm long and 80µm thick on central area). Radial shields elongated, narrow, raised, covered in plates, converging and almost meeting at centre of disc. Oral shields absent, adoral shields indistinct. Jaws covered by minute granules. Teeth seven, broad, triangular, lowermost appearing to be paired. Genital slits short, wide. Arms five, slender, coiling, narrow, higher than wide. No arm spines from first pair of tentacle pores to segment 15, then two arm spines, one slightly smaller. Arm spines short, innermost longest and cigar-shaped, finely serrated. Colour in life pink (McKnight, 2000).

Global distribution
New Zealand (McKnight, 2000), South Africa.

Ecology
Depth range: 341-1800m (Lyman, 1879; Baker, 1980; McKnight, 2000).
Habitat: No details recorded.

Remarks
Single specimen recorded off KZN south coast, previously only known from waters off New Zealand and is a noteworthy extension into the Indian Ocean. According to Baker (1980), type locality is west of Raoul Island, Kermadecs, depth 1152m. Holotype housed in the Natural History Museum, London (BMNH 82.12.23.271B).

Family GORGONOCEPHALIDAE Ljungman, 1867

***Astroboa nuda* (Lyman, 1874)**

Astrophyton nudum Lyman, 1874: 251-252, pl. 6, figs 4-5.
Astrophyton elegans Koehler, 1905a: 123-125, pl. 13, fig. 2, pl. 18, fig. 1.
Astroboa nuda: Döderlein, 1911: 86-88; Mortensen, 1940: 67; Tsurnamal and Marder, 1966: 9-17, figs 1-4; Clark and Courtman-Stock, 1976: 100, 108, 130-131; Cherbonnier and Guille, 1978: 17-18, pl. 1, figs 3-4; Baker, 1980: 60, fig. 22; Guille and Vadon, 1985: 62; Marsh, 1986: 70.
Astroboa nigra Döderlein, 1911: 83-86, pl. 9. figs 9, 9a.
Astroboa nuda var. *elegans*: Döderlein, 1927: 45.
Astroboa nuda var. *nigra*: Döderlein, 1927: 44; Balinsky, 1957: 2-3.

Material / Records
Data Record Sink *et al.,* 2006-6, -27.4817°, 32.7117°, Sodwana Bay, Wright Canyon, depth 70-120m, ROV, November 2000, Determined by Gordon Paterson. Data Record Sink *et al.,* 2006-55, -27.5263°, 32.7198°, Sodwana Bay, Jesser Canyon, depth 100-110m, ROV, November 2000, determined by Gordon Paterson. Data Record SANBI, iSpot, -27.5355°, 32.6799°, Sodwana Bay Canyons, depth 69m, 1 March 2014, determined by K. Sink.

Diagnosis *(See Clark and Courtman-Stock, 1976; Baker, 1980)*
D.D. up to 92mm. Disc depressed interradially and centrally, interradial and radial areas naked towards centre of disc, but with an increasing presence of tiny tubercles towards disc margin. Radial shields narrow, paved densely with low granules giving smooth appearance, raised at disc margin, slightly broader on distal side terminating in oval slightly concave plate, converging to centre of disc. Oral papillae short, narrow, no continuous fringe in distal notches. Teeth three to five, thicker than oral papillae but elongated. Genital slits small, wide. Genital papillae present on inner edge. Ventral interradial areas densely covered with tiny tubercles. Madreporite one. Arms higher than wide basally, branching, first fork close to disc base, four to eight segments between forks with up to 28 forks along arm. Arms covered in small, smooth, polygonal plates, girdle belts present on arms from after second fork, but continuous before third branch, girdle hooklets with single secondary tooth. Arm spines absent before fifteenth fork, spines 3-4 with distal spines becoming hooklets with two hooks. Colour in life black, white or yellow.

Global distribution
Indo-Pacific, Australia, Western Indian Ocean, Red Sea, Persian Gulf, East Indies, China and south Japan, Philippines, Madagascar, Mozambique (Balinsky, 1957; Kalk, 1958; Macnae and Kalk, 1958;

Tsurnamal and Marder, 1966; Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Cherbonnier and Guille, 1978; Rowe and Gates, 1995; Richmond, 2002), South Africa (Sink *et al.*, 2006).

Ecology
Depth range: 0.5-120m (Tsurnamal and Marder, 1966; Sink *et al.*, 2006).
Habitat: Found on coral reefs, both within deep crevices and on open reef.

Remarks
Previously known in Mozambique and hence not surprisingly recorded in South Africa. According to Rowe and Gates (1995), type locality is the Philippines, with the holotype being held at the Museum of Comparative Zoology (MCZ OPH-2911).

Astroglymma cf. *sculptum* (Döderlein, 1896)
(Plate 2.1C, D)

Astrophyton sculptum Döderlein, 1896: 299, pl. 18, fig. 29a, b; Baker, 1980: 66, 74, figs 19, 28, 31.
Astroglymna sculptum: Rowe and Gates, 1995: 365 (*lapsus calami*).
Gorgonocephalus robillardi De Loriol, 1899: 31-34, pl. 3, fig. 3.
Astrodactylus robillardi: Döderlein, 1911: 96-98.
Astroglymma sculptum Döderlein, 1927: 47-50, pl. 1, figs 3, 4; pl. 5, fig. 13; Koehler, 1930: 15, pl. 2, figs 10-12; Guille and Vadon, 1985: 62; Okanishi *et al.*, 2011c: 380-381, fig. 7.
Astroglymma robillardi: Mortensen, 1933e: 34, pl. 3, figs 1, 2; pl. 4, fig. 1.

Material / Records
SAMC A74047, -27.7668°, 32.6500°, NE Gypsea Hill, depth 84-90m, 9 June 1990, *Meiring Naude*, station number ZK22, Natal Museum Dredging Programme. USNM 1072476, -29.4500°, 31.5100°, east of Durban, *Anton Bruun*, station number 394B, depth 68-70m, 25 September 1964, determined by A.N Baker.

Diagnosis *(See Baker, 1980)*
D.D. up to 50mm. Disc deeply excavated interradially. Radial shields long, slender, widely separated distally almost touching proximally, almost reaching centre of disc. Disc and radial shields covered in minute conical tubercles, ventral interradial area may bear long spinelets. Five madreporites present in angle of ventral interradial area. Oral shields smooth, adoral shields not distinct, deep pits bordering jaws. Oral papillae unequal, small, mostly spiniform. Teeth small, spatulate. Genital slits short, D-shaped. Genital papillae blunt-tipped on outer edge. Arms branching, first fork just beyond disc, forking at least 20 times along arm. Dorsal arms covered in low polygonal plates. Girdle belts narrow, present from arm bases, girdle hooklets with secondary tooth. Arm spines present from sixth fork as two stumps, becoming three with one or two terminal points, distally becoming hooklets with terminal point and smaller secondary tooth. Ventral arms covered with smaller flat polygonal plates, the ventral arms have ladder-like pits on first 2-3 forks.

Global distribution
Indo-West Pacific, Australia, India, Mauritius, Malaysian Archipelago, China Sea (Baker, 1980; Imaoka *et al.*, 1991; Rowe and Gates, 1995), South Africa.

Ecology
Depth range: 7-300m.
Habitat: On continental shelf and slope (Rowe and Gates, 1995).

Remarks
Baker (1980) synonymised *Astroglymma robillardi* with *A. sculptum*, agreeing with Mortensen (1933e) that there were no reliable differences between *sculptum* and *robillardi* and that a specimen being found in the Indian Ocean gave no reason to have separate species. He did note that Mortensen's *A.* var. *spinosum* may have merit but without comparative material, it should remain a variety. In this study, the specimen of *Astroglymma* described from off Durban had some noticeable differences; however, not those that Mortensen used to differentiate *A. robillardi* from *A*. var. *spinosum*. Mortensen (1933e) used the following to differentiate *sculptum* from *spinosum*: i) *spinosum* disc has thick stumps ending in some hyaline thorns with similar stumps on radial shields, except they are close-set in comparison to *sculptum*. Ventrally, few stumps present. The specimen at hand (SAMC A74047) had fine tubercles and were close together, giving a smooth appearance, while ventrally, the disc covering was similar to the dorsal disc; ii) in *A.* var. *spinosum* there were no distinct grooves on the oral frame and no ladder pits on proximal part of arm. In SAMC A74047 these pits were present; iii) the arm spines in *A*. var. *spinosum* begin before the first fork and the primary hooks are larger and different in shape (*A.* var. *spinosum* hooks are hunched over) to *sculptum*. In SAMC A74047, there are very few hooks on the arm spines and they begin from the fourth fork.

In addition to not being similar to *A.* var. *spinosum*, SAMC A74047 also has a number of differences from *A. sculptum*: i) arm spines start from the fourth fork and not the sixth as in *sculptum;* ii) distal arm spines have hooks but very few with secondary hooks; iii) girdle hooklets only have a terminal hook, therefore no secondary hooks are present on girdle belts as described by De Loriol (1899), Baker (1980) and Mortensen (1933e); and iv) there are 8-10 forks on SAMC A74047 which is fewer than those for *sculptum* (up to 20 forks). Therefore, it is noted that SAMC A74047, does not strictly conform to *sculptum*, *robillardi* or var. *spinosum*.

The second record for South Africa is held at the Smithsonian Institution, National Museum of Natural History in Washington, D.C. (USNM), (USNM 1072476). The type locality of this species is Amboina, Indonesia.

Family OPHIOMYXIDAE Ljungman, 1867

***Ophiomyxa australis* Lütken, 1869**
(Plate 2.1E, F)

Ophiomyxa australis Lütken, 1869: 45, 98, 99; Lyman, 1882: 246; Koehler, 1907: 341, Benham, 1909: 101; Clark, 1915a: 168, pl. 1, figs 1-2; Clark, 1916: 77; Matsumoto, 1917: 19-21, fig. 3, pl. 1, figs 4-7; Clark, 1938: 201, pl. 13, figs 1-21; Clark, H.L., 1939: 36-37; Clark, 1946: 170-171; Madsen, 1967: 141; Clark and Rowe, 1971: 78, 92-93, pl. 13, figs 3, 4; Devaney, 1974: 115-116; Cherbonnier and Guille, 1978: 18-19, pl. 3, figs 1, 2; Sloan *et al.*, 1979: 99, figs 5, 6; Irimura, 1982: 2-4, fig. 1; Guille and Vadon, 1985: 62; Sastry, 1991: 375-376; Rowe and Gates, 1995: 406; Mbongwa, 2013: 15.
Ophiomyxa brevispina Von Martens, 1870: 249-50; De Loriol, 1893b: 425-426; Döderlein, 1896: 298, pl. 17, fig. 27; Koehler, 1905a: 119; Clark, 1915a: 170, pl. 1, figs 1, 2; Koehler, 1930: 48.
Ophiomyxa robillardi De Loriol, 1893a: 53-54, pl. 25, fig. 5.
Ophiomyxa brevispina var. *irregularis* Koehler, 1898b: 111-112.
Ophiomyxa irregularis Koehler, 1905a: 119-120, pl. 12, fig. 1; Koehler, 1922b: 17-20, pl. 2, fig. 18, pl. 5, figs 1, 2, pl. 6, fig. 4, pl. 92, fig. 2; Koehler, 1930: 48.

Material / Records

RMCA MT2305, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, no depth, 10 February 2001, collected by Y. Samyn, determined by Y. Samyn and M. Garcia. RMCA MT2274, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 13m, 9 August 1999, collected by Y. Samyn, determined by Y. Samyn and M. Garcia. RMCA MT2361, -27.5227°, 32.6919°, Sodwana Bay, depth 30m, 14 August 1999, collected by Y. Samyn, determined by Y. Samyn and M. Garcia. SAMC A28127, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 24 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28133, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 25 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28140 and SAMC A28142, -27.5166°, 32.6833°, Sodwana Bay, depth 14m, 1 August 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. EKZNW SB_4_JMO_2010, -27.8667°, 32.6000°, Leadsman Shoal, depth 11m, SCUBA, 13 October 2010, determined by J.M. Olbers. SAMC A74042, -27.1000°, 32.8841°, off Dog Point, depth 74m, 7 June 1990, dredge, *Meiring Naude*, station number ZC10, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74043, -27.1844°, 32.8350°, off Rocktail Bay, depth 75m, 4 June 1987, dredge, *Meiring Naude*, station number ZD2, Natal Museum Dredging Programme, determined by J.M. Olbers.

Diagnosis *(See Cherbonnier and Guille, 1978)*

D.D. up to 23mm. Disc pentagonal, covered with thick, opaque, smooth skin. Radial shields short, narrow, separated by width of arm base; disc margin scales overlap. Genital slits bordered by plates similar to ones on disc margin, long, narrow. Oral shields oval, triangular, covered by thick skin, longer than wide, abutting genital slit. Oral papillae three, broad, serrated, flattened and transparent on edges. Teeth similar. Arms five, covered in thick naked skin. Arm spines up to seven, one on segment one, then two and four on first free arm segments. Arm spines slender, serrated and rugose at tip, some becoming curved or slightly hooked. Dorsal arm plates irregular, fragmented, becoming less fragmented distally. Ventral arm plates distinctly broader than long, deep notch on distal side, not contiguous distally. Tentacle scales absent. Colour in life blood-red dorsally and ventrally, arms lightly banded with yellow.

Global distribution

East Africa and Islands, Madagascar, Kenya, Mascarene Basin, Red Sea, Seychelles, Somalia, Tanzania, Western Indian Ocean, New Zealand (Stöhr *et al.*, 2014), Indo-West Pacific (Rowe and Gates, 1995), South Africa (Mbongwa, 2013).

Ecology

Depth range: 11-75m.

Habitat: In sand, grey ooze, coral, crannies in coral, stones and gravel, mud, sandstone rubble, gorgonians (Lyman, 1882; Clark, 1938).

Remarks

According to Rowe and Gates (1995), the type locality is Bass Strait (as '…inter Australian et Tasmaniam') with the syntypes being held at the Natural History Museum of Denmark (ZMUC OPH-474) (Tom Schiøtte, pers. comm.).

Family OPHIURIDAE Lyman, 1865

Subfamily **Ophioleucinae** Matsumoto, 1915

Ophiernus quadrispinus Koehler, 1908

(Plate 2.2A, B)

Ophiernus quadrispinus Koehler, 1908a: 533, 601-602; pl. 10, figs 102, 103; Koehler, 1908b: 142,146; Madsen, 1977: 120-121, fig. 7; Billett *et al.*, 2013: 20-25.

Material / Records

SAMC A22018, off Saldanha Bay, -33.8116°, 16.5000°, depth 2730m, 27 August 1959, trawl, *Africana II*, station number A193, determined by A.M. Clark. SAMC A22015, -34.6166°, 17.0500°, off Cape Town, depth 2875-2948m, 8 December 1959, trawl, *Africana II*, station number A315, determined by A.M. Clark. Data Record Madsen, 1977, -34.4044°, 17.7437°, off Cape Point, depth 1700-1900m, *Fisheries Survey*.

Diagnosis *(See Madsen, 1977)*

D.D. up to 7mm. Disc pentagonal, covered in scales, dorsally and ventrally, scales slightly bigger abutting radial shields and genital slits. Sparse granules on disc margin extending onto margins of radial shields. Radial shields, large, oval, longer than wide, separated by disc scales. Oral shields spearhead-shaped, naked. Adoral shields not distinct, extending up to first ventral arm plate, may or may not be contiguous proximally. Jaws long. Oral papillae five to six, including two smaller papillae in series with scales around second oral pore. Teeth three to four, tapering to blunt point. Genital slits as long as interradial area, genital papillae absent. Ventral arm plates bell-shaped, first plate sunken, contiguous proximally becoming reduced and separated distally. Dorsal arm plates wider than long, distal edge straight proximally, becoming convex distally. Lateral arm plates increasing in size distally, hosting arm spines. Arm spines four, delicate, cylindrical, pointed, shorter than segment length, decreasing distally. Arm spines placed on mid-plate proximally, moving dorsally distally, upper bristle-like arm spine absent. Arms moderately long (all specimens broken), dorsal arm with slight keel. Tentacle scales two, sometimes one, varying in shape from pointed to round, unequal in size.

Global distribution

South Georgia and Crozet Island, Southern Ocean, Southern Atlantic, near the South Orkneys (Madsen, 1977; Billett *et al.*, 2013), South Africa (Madsen, 1977).

Ecology

Depth range: 1700-3250m (Madsen, 1977).
Habitat: No information available.

Remarks

Although these specimens were trawled in 1959 and identified by A.M. Clark (date of determination unknown), they were not included in the Clark and Courtman-Stock (1976) monograph for unknown reasons. Later, Madsen (1977) described this species as a new record for South Africa. Granules on disc margin similar to *O. vallincola* Lyman, 1878, but fewer in number. Similarly, granules extend onto margins of radial shields, but again fewer in number. Dorsal arm plates wider than long, but slightly wider than in *O. vallincola*. Type locality is Southern Ocean (Koehler, 1908a). In addition, the two similar species, *O. seminudus* and *O. quadrispinus* both lack the bristle-like supplementary spines on the lateral arm plates, whereas these are present on *O. vallincola*.

Subfamily **Ophiurinae** Lyman, 1865

Amphiophiura sculptilis (Lyman, 1878)

Ophioglypha sculptilis Lyman, 1878: 84-85, pl. 4, figs 115, 116; Lyman, 1882: 37.
Ophioglypha variabilis Lyman, 1878: 85-86, pl. 4, figs 113, 114; Lyman, 1882: 37.
Ophiura sculptilis: Ludwig, 1901: 925; Clark, 1911: 77.
Ophioglypha remota Koehler, 1904a: 54, pl. 9, figs 1-3.
Amphiophiura sculptilis Koehler, 1914a: 24; Koehler, 1922b: 364; Clark, 1915a: 313; Matsumoto, 1915: 77; Hertz, 1927a: 74; Clark, H.L., 1939: 108; Madsen, 1951: 114; Litvinova, 1971: 299, pl. 3, figs 2, 4, 5; Vadon and Guille, 1984: 588, 592-593, pl. 5, 1-4; Guille and Vadon, 1986: 169; Manso, 2010: 196.

Material / Records
Data Record Guille and Vadon (1986), -29.8133°, 34.5450° off Durban, depth 2608m, 21 August 1979, dredge, Safari I (*Marion-Dufresne*), station number DS1, determined by A. Guille and A. Vadon.

Diagnosis *(See Lyman, 1878; Vadon and Guille, 1984)*
D.D. up to 15mm. Dorsal disc thick, scales thin and flat, large round central plate, five distinct plates separated by small, irregular scales. Radial shields distinct, D-shaped, contiguous distally, tapering proximally with wedge of scales between them, large scale present on dorsal interradial area. Ventral interradial areas scaled, but dominated by large oral shield. Oral shield pentagonal, distal edge rounded, slightly longer than wide, covering most of ventral disc surface. Adoral shields relatively broad, contiguous. Oral papillae five, broad, closely set, apical papillae blunt. Genital slits moderately long, genital papillae present, squarish becoming spiniform, forming arm combs dorsally. Dorsal arm plates fan-shaped, rounded distal edge, contiguous. Lateral arm plates broad, meeting ventrally. Ventral arm plates squat, bell-shaped, constricted by large tentacle pore, distal edge longer than proximal edge, wider than long, distal edge straight becoming rounded, not contiguous. Arm spines up to six, blunt. Tentacle pores large, tentacle scales up to five within disc, two on remaining arm.

Global distribution
Antarctic Ocean, Northern Atlantic, Southern Atlantic, Zanzibar, Oman, Réunion, Indonesia, Japan, South America, Brazil, Bay of Bengal (Koehler, 1914a; Koehler, 1922b; Clark, H.L., 1939; Vadon and Guille, 1984), South Africa (Guille and Vadon, 1986).

Ecology
Depth range: 300-4 320m (Vadon and Guille, 1984).
Habitat: Grey sand, *Globigerina* ooze, grey mud (Koehler, 1914a; Koehler, 1922b).

Remarks
Single record from South Africa, collected during French expedition Safari I on *Marion-Dufresne*, reported by Guille and Vadon (1986). Type locality is off Japan.

Family AMPHIURIDAE Ljungman, 1867

***Amphilimna cribriformis* A.M. Clark, 1974**
(Plate 2.2C, D)

Amphilimna cribriformis Clark, 1974: 442-444, fig. 1a-d; Thomas, 1975: 131, 132, 137; Clark and Courtman-Stock, 1976: 122, 165, 166, figs 182, 183; Liao, 1989: 342.

Material / Records
SAMC A22784 (disintegrated holotype), NE of Durban, depth 118m, -29.5670°, 31.6500°, dredge, sandy green brown mud, 9 September 1964, station number NAD40V; SAMC A22787 (paratype), NE of Durban, depth 86m, -29.4833°, 31.7500°, dredge, mud, 9 September 1964, station number NAD52E; SAMC A22785 (paratype), one specimen in poor condition, off Zimbali, depth 115m, -29.5670°, 31.6500°, dredge, mud, no station data or collection date; SAMC A22788 (paratype), NE of Tongaat, depth 150m, -29.5833°, 31.6333°, dredge, sandy green brown mud, 9 September 1964, station number NAD35W; SAMC A22789 (paratype), off Zimbali, depth 118m, -29.5677°, 31.6519°, dredge, sandy green brown mud, 9 September 1964, station number NAD43G; SAMC A22790 (paratype), off La Mercy, depth 200m, -29.6333°, 31.6019°, dredge, mud, 8 September 1964, station number NAD33B; SAMC A22791 (paratype), off Sheffield Beach, depth 86m, -29.4833°, 31.7500°, dredge, mud, 9 September 1964, station number NAD55C.

Diagnosis *(See Clark, 1974; Clark and Courtman-Stock, 1976)*
D.D. up to 6.5mm. Disc pentagonal, indented radially, uniformly white, both dorsally and ventrally due to preservation. Dorsal and ventral disc covered in medium-sized fine disc scales with scattered, tapering, sharp spinelets, no change in spinelet, scale density or size on disc margin. Radial shields long, narrow, spines may be absent. Genital plates large, lie at angle in which they appear to be overlapping, each plate hosting two stout spines at dorsal end. Oral shields triangular with rounded angles, as long as wide, widest distally. Adoral shields restricted to lateral edge of oral shield, triangular with inner margin curved, not contiguous. Jaws slightly elongated, two to four asymmetrical apical oral papillae, three spinose distal papillae, two distalmost being on edge of adoral shield. Teeth single, broad, with small elongated oral tentacle scale either side. Arms long and thin, first two to four dorsal arm plates short, compressed or rudimentary, narrow. First free arm plate fan-shaped with convex distal edge, as long as wide, narrowly contiguous, plates translucent, porous and brittle with underlying structure visible. First ventral arm plate appearing triangular, adjacent to adoral shields, second arm shield with straight distal edge, broader between tentacle pores. Ventral arm plates thereafter with slight convex edge, becoming concave distally, narrowing adjacent to tentacle pores, longer than broad. Arm spines six, with first seven to nine arm plates hosting flattened, webbed arm spines, forming a wing-like flange which excludes lowermost spine. Beyond disc, arm spines free, flattened, becoming round and tapering distally. Tentacle scales two on segments one to ten, outer scale small, inner scale spinose resembling an arm spine, becoming reduced and eventually completely lost, single tentacle scales after segment ten.

Global distribution
Mozambique, South Africa (Clark, 1974; Clark and Courtman-Stock, 1976).

Ecology
Depth range: 86-200m.
Habitat: Sandy mud, continental shelf (Clark, 1974; Thomas, 1975; Clark and Courtman-Stock, 1976).

Remarks
Upon examination, it was found the holotype has disintegrated, it is suggested that if a neotype were to be erected, the paratype SAMC A22787, collected 13km from original type locality, would be the most appropriate specimen, because this individual, one of nine paratypes, is probably in the best condition.

In 1899, Verrill placed *Amphilimna* into the family Amphiuridae, which was supported by Clark (1915a) and Koehler (1922b). Later in 1967, Thomas, placed *Amphilimna* into the Ophiacanthidae, which was supported by Clark (1974), Clark and Courtman-Stock (1976) and Liao (1989). Paterson (1985) then placed it into a subfamily Ophiotominae (family Ophiacanthidae). In 2010, Martynov, proposed to place *Amphilimna* back into the Amphiuridae, as suggested by Verrill (1899b), despite having an atypical dental plate. This genus has been dubbed an aberrant genus between Amphiuridae and Ophiacanthidae.

Amphioplus (Lymanella) depressus **(Ljungman, 1867)**
(Plate 2.2E, F)

Amphipholis depressa Ljungman, 1867b: 312.
Ophiophragmus affinis Duncan, 1887: 89-90, pl. 8, figs 4-6.
Amphiura relicta Koehler, 1898b: 69, pl. 4, figs 37, 38; 4, pl. 16 figs 15, 16.
Amphioplus relictus: Clark, 1915a: 256; Clark, 1938: 251.
Amphioplus depressus: Clark, 1915a: 254; Clark, 1946: 205; James, 1970: 142-144, fig. 1g-k.
Amphipholis hastata Ljungman, 1867b: 313.
Amphioplus hastatus: Clark, 1915a: 257; Clark, 1923: 331; Koehler, 1927: 6; Clark, H.L., 1939: 75-76; Day and Morgans, 1956: 308; Clark, 1967: 47; Vine, 1986: 195.
Amphioplus (*Lymanella*) *hastatus*: Clark, 1970: 51, 54-55, fig. 9p, q; Clark and Rowe, 1971: 80, 102, fig. 24a; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 81, 83-86, figs 36, 37; Sloan *et al.*, 1979: 101; Richmond, 2002: 326.
Amphioplus (*Lymanella*) *depressus*: Clark, 1970: 54; Clark and Rowe, 1971: 102; Gibbs *et al.*, 1976: 117-118; Baker, 1979: 46.

Material / Records
DBN52H, -29.8660°, 31.0270°, Durban Bay, depth 0m, 18 July 1950, collected by hand, UCT Ecological Survey Collection, determined by unknown. SAMC A74078, -34.0817°, 23.0126°, Knysna, depth 0m, 7 July 1960, collected by hand, UCT Ecological Survey Collection, determined by T. O'Hara. Data Record Mbongwa, 2013, -27.7320°, 32.6264°, Sodwana Bay, depth unknown, 27 February 2013, determined by J.M. Olbers and N.A. Mbongwa.

Diagnosis *(See Clark, 1970; Clark and Rowe, 1971)*
D.D. up to 10mm. Primary rosette may or may not be distinct. Disc scales moderate in size, overlapping, central scales may be larger than peripheral scales. Disc margin sharp, sometimes with small projections or spines. Radial shields contiguous for half their lengths, may be half disc radius or less. Oral shields narrow, diamond-shaped, longer than wide, adoral shields triangular, contiguous. Oral papillae four, arranged in continuous row forming a straight line, third papilla slightly enlarged. Arm length approximately 6-7 times disc diameter. Dorsal arm plates oval, wider than long, distal margin convex, contiguous. Ventral arm plates pentagonal, flat distally, narrowly contiguous. Arm spines up to three, pointed, about as long as segment. Tentacle scales two, large covering pore.

Global distribution
Arabian Sea, Persian Gulf, Bay of Bengal, Red Sea, Madagascar, Australia, Mozambique, Indonesia, Philippines, Australia, Fiji and Japan (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Baker, 1979; Rowe and Gates, 1995), South Africa.

Ecology
Depth range: 0-82m.
Habitat: Associated with seagrass (*Syringodium isoetifolium* and *Cymodocea serrulata*), mud and sand (Cherbonnier and Guille, 1978), mud (James, 1970) and detritus.

Remarks
Mortensen (1940) stated that the marginal spines are not diagnostic for *hastatus*, given that specimens from the Persian Gulf are inconsistent. Later Clark (1946) stated that it was doubtful that *hastatus* could be distinguished from *A. (Lymanella) depressus* because they have relatively broad radial shields, no distinct median distal angle on their dorsal arm plates and often the marginal scales are more or less specialised. In addition, he also mentioned that the prominent primary rosette is not a reliable character because of the likelihood of loss and regeneration; this was further supported by Clark (1970). Clark and Rowe (1971) distinguished *hastatus* from *depressus* using the distinctness of the primary rosette, size of the radial shields and whether there were spines on the disc margin, all of which were considered unlikely to be distinguishing characters by Mortensen (1940), Clark (1946), Clark (1970) and Baker (1979). Therefore, based on the material at hand and these characters, it is believed that *hastatus* is a synonym of *depressus*. A.M. Clark found that the South African records of *Amphioplus* (*Lymanella*) *hastatus* reported by Day and Morgans (1956) and by Day (1974) are in fact misidentifications of *Amphioplus (Lymanella) integer* (Clark and Courtman-Stock, 1976). The type material of *Amphipholis hastata* Ljungman, 1867 is in the Swedish Museum of Natural History (SMNH-Type-1431) Stöhr (2001) and the type locality is Mozambique (Ljungman, 1867b).

Ophionephthys lowelli A.M. Clark, 1974
(Plate 2.3A, B)

Ophionephthys lowelli Clark, 1974: 462-464, fig. 10a-e; Clark and Courtman-Stock, 1976: 103, 116-117, 159-160; Mbongwa, 2013: 15.

Material / Records
SAMC A22782 (disintegrated holotype), off East London, depth 55m, -33.0500°, 27.9000°, dredge, brown sand and shell, 17 July 1959, station number SCD82P; SAMC A22781 (paratype), NE of East London, depth 55m, -32.5505°, 28.6352°, dredge, sand and mud, 16 July 1959, station number SCD74S; SAMC A74075, Sodwana Bay, depth 0m, -27.5396°, 32.6804°, by hand, collected by Rebecca Milne, among algae, 15 October 2010, identified by J.M. Olbers; Unaccessioned (UKZN), Sodwana Bay, no depth, -27.7320°, 32.6264°, SCUBA, 27 February 2013, identified by J.M. Olbers.

Diagnosis *(See Clark, 1974; Clark and Courtman-Stock, 1976)*
D.D. up to 8mm. Disc round, in all specimens at hand the dorsal disc 'lid' is missing. Oral shields variable, as long as wide or wider, triangular with broadly rounded angles, widest proximally or rhombic with proximal lobe flattened. Adoral shields triangular, widely separated interradially, with broad distal lobe contiguous with lateral arm shield. Jaws slightly sunken, with two large, broad infradental oral papillae, appearing in preserved specimens to be apical papillae. Two spiniform, rugose-tipped oral papillae, one shorter than the other and both attached to oral plate and in series with infradental papillae. Oral tentacle scale distinct, short and sharp, situated close to teeth. No genital papillae,

genital slits small and indistinct. Arms long, approximately ten times disc length, first seven to nine dorsal arm plates rudimentary, showing underlying structure, plates becoming whole, square or slightly longer than broad, with rounded edges slightly convex on distal side and concave on proximal side, broadly contiguous. Ventral arm plates similar in shape, convex distally, overlapping each other, longer than broad. Arm spines four or five, lowest one thick, blunt, approximately segment length, remaining spines slightly shorter and tapering but blunt, covering not smooth, slightly rough. Tentacle scale single, oval, longer than broad, moderate in length, *c.* half segment length.

Global distribution
South Africa (endemic).

Ecology
Depth range: 0-55m.
Habitat: Found in brown sand, shell and mud and coral sand (Clark, 1974; Clark and Courtman-Stock, 1976).

Remarks
During this study, the holotype was borrowed for examination, but found to have disintegrated in the jar. If a neotype were required to be erected, it is suggested that one of the seven paratype specimens (SAMC A22781) be selected, because these were collected 90km from the original type locality and appear to be in reasonable condition.

Clark (1974) mentioned that her figure of the dorsal disc was reconstructed because the upper side was probably covered with extremely fine scaling, towards the periphery where it turns brown when partially dried. No specimens available for examination here (paratypes and one new specimen) had any dorsal disc resemblance to the reconstructed dorsal disc in Clark (1974), i.e. they were all missing their dorsal disc 'lids'. The single fresh specimen available for examination was uniformly white, both dorsally and ventrally, with no distinct markings or colouration.

Family OPHIACTIDAE Matsumoto, 1915

***Ophiactis* cf. *picteti* (de Loriol, 1893)**
(Plate 2.3C, D)

Ophiocnida picteti De Loriol, 1893b: 405-407, pl. 13, fig. 2.
Ophiactis picteti: Clark, 1915a: 267; Clark and Rowe, 1971: 82,104; Cherbonnier and Guille, 1978: 123-125, fig. 56; Sloan *et al.*, 1979: 101-102; Humpreys, 1981: 10, 21; Milne, 2012: 155.

Material / Records
RMCA MT2275, -30.9620°, 30.3050°, Trafalgar, KZN, depth 25m, 21 August 1999, SCUBA, collected by Y. Samyn, determined by M. Garcia. SAMC A28136, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 28 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A74053, SAMC A74056, SAMC A74060, SAMC A74070, SAMC A74071, SAMC A74072 and SAMC A74073, -27.5230°, 32.6920°, Sodwana Bay, depth 7.5m, 15 October 2010, SCUBA, ACEP II, determined by J.M. Olbers. SAMC A74063 and SAMC A74065, -27.5230°, 32.6920°, Sodwana Bay, depth 12.5m, 15 October 2010, SCUBA, ACEP II, determined by J.M. Olbers. SAMC A74057, -27.5230°, 32.6920°, Sodwana Bay, depth 22m, 15 October 2010, SCUBA, ACEP II, determined by J.M. Olbers. SAMC A74069, -27.5230°, 32.6920°, Sodwana Bay, depth unknown, 15 October 2010, SCUBA, ACEP II, determined by J.M. Olbers.

Diagnosis *(See Cherbonnier and Guille, 1978)*
D.D. up to 6mm. Disc round, dorsally covered with overlapping scales, many conical small spinelets mainly in interradial areas and on margin. Ventral interradial areas with finer scales, scattered conical spines. Arms five, simple. Radial shields elongated, narrow triangular, length at least two-thirds disc radius, each pair separated by four enlarged scales, distally approximating or contiguous, light patch on distal part of each radial shield. Genital slits ending at edge of disc, no distinct scales, genital papillae absent. Oral shields spearhead-shaped or oval, slightly wider than long, may be truncated on distal side. Adoral shields contiguous interradially, single apical papillae, two to three distal oral papillae. Up to seven arm spines (usually six), short, longest less than twice segment length, tapering to blunt tips, three uppermost ones stout and conical and rugose, remaining spines elongated and decreasing in size toward ventral side. Dorsal arm plates oval, becoming elliptical, wider than long, distal edge convex, broadly contiguous. Ventral arm plates hexagonal, edges rounded in proximal part of arm, becoming flat-truncated on both sides, slightly wider than long. Single tentacle scale large, round. Colour in life, disc and arms brown with white, marbled, arms banded sometimes with dark spots, ventrally arms white, spinelets white.

Global distribution
East Indies, Indo-Malayan Region, Western Indian Ocean, Australia, Madagascar, Kenya and Tanzania (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Humpreys, 1981; Rowe and Gates, 1995), South Africa (Milne, 2012).

Ecology
Depth range: 0-50m.
Habitat: Coral patches, coral reef flats (Humpreys, 1981).

Remarks
In South Africa, as Sloan *et al.* (1979) suggested, *O. picteti* has also been misidentified as *O. hemiteles* in some works. Milne (2012) reported *O. hemiteles* collected in Sodwana Bay (initially identified by J.M. Olbers), but these were re-examined again by J.M. Olbers and were found to be *O. picteti* based on the presence of the narrow median distal lobe (Sloan *et al.*, 1979) and the blunt arm spines.

Clark and Rowe (1971) used skin-covered oral shields as a character, but in the specimens on hand, which were dry on examination, these do not show the oral shield obscured. In addition, Cherbonnier and Guille (1978) mentioned that the adoral shields are small, but in the specimens at hand, the adoral shields could be adequately seen. Although the arms are broken on all specimens at hand, it is noted that De Loriol (1893b) also suggested that the disc diameter and arm length ratio was approximate in the descriptions, which is D.D./A.L. = 1/6. In addition, Sloan *et al.* (1979) stated that the Indian Ocean specimens have a narrow median distal lobe on the oral shields, which is true of the specimens at hand.

According to Rowe and Gates (1995) the type locality is Amboina, Indonesia, and the holotype was thought to be held at the Natural History Museum in Genève, but upon investigation, this was not the case (Jean Mariaux, pers. comm.).

Family OPHIOCOMIDAE Ljungman, 1867

***Ophiocomella sexradia* (Duncan, 1887)**
(Plate 2.3E, F)

Ophiocnida sexradia Duncan, 1887: 92-93, pl. 8, fig. 10, 11; Koehler, 1905a: 33.
Ophiocoma parva Clark, 1915a: 292, pl. 14, figs 8, 9; Clark, 1921: 132, pl. 13, fig. 4; Clark, 1938: 331-332; Clark, A.H., 1939: 5-7, pl. 1, figs 1, 2; Clark, 1946: 247; Balinsky, 1957: 27; Kalk, 1958: 207, 216, 237; Macnae and Kalk, 1969: 104, 106, 130; Clark and Rowe, 1971: fig. 38d.
Amphilimna sexradia: Clark, 1915a: 259.
Amphilimna sexradiata: Koehler, 1927: 3.
Ophiocomella clippertoni: Clark, A.H., 1939: 5-7 (as *O. parva*); Clark, A.H., 1952: 296.
Ophiocomella schultzi Clark, 1941: 481-483; Clark and Rowe, 1971, fig. 38c, e.
Ophiomastix sexradiata Clark, A.H., 1952: 297-298; Clark and Rowe, 1971: 86, 118, fig. 38a, b.
Ophiocomella sexradia: Clark and Rowe, 1971: 86-87, 118, fig. 38c-f; Devaney, 1974: 162-164; Clark and Courtman-Stock, 1976: 105, 122, 175; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 178-179, pl. 12, figs 5, 6; Sloan *et al.*, 1979: 109; Vine, 1986: 195; Sastry, 1991: 374, 382, pl. 4, fig. 20; Rowe and Gates, 1995: 389; Richmond, 2002: 326; Putchakarn and Sonchaeng, 2004: 423; Stöhr *et al.*, 2008: 547, 555-556; Mbongwa, 2013: 16.

Material / Records
EKZNW RR_9_JMO_2010, -29.9861°, 30.9645°, Reunion Rocks, intertidal, 27 February 2010, collected and determined by J.M. Olbers. EKZNW RR_7_JMO_2010, -29.9861°, 30.9645°, Reunion Rocks, intertidal, 30 January 2010, collected and determined by J.M. Olbers. EKZNW RR_4_JMO_2010, -29.9861°, 30.9645°, Reunion Rocks, intertidal, 24 September 2010, collected and determined by J.M. Olbers.

Diagnosis *(See Clark and Courtman-Stock, 1976; Cherbonnier and Guille, 1978)*
D.D. up to 6mm. Disc covered with short, blunt spines, densities may differ. Radial shields not distinct. Oral shields variable, round, rhombic, spearhead-shaped or hexagonal. Adoral shields not contiguous. Dental papillae four to six, usually in series. Oral papillae three. Teeth blunt and wide. Genital slits narrow and elongated. Arms six, rarely three or seven. Dorsal arm plates fan-shaped, as wide as long. Ventral arm plates squarish, distal edge rounded, proximal edge truncated. Arm spines up to four, sometimes five, tapering to blunt tip or may be square tipped, one segment length. Tentacle scale one, oval, first pair of pores may have two. Fissiparous. Colour in life, disc dark brownish or green, arms banded with brown, green or red.

Global distribution
Indo-Pacific, Mozambique, China, India, south Japan, Australia, Tasman Sea, Reunion, Rodrigues, Hawaiian Islands (Clark and Rowe, 1971; Sastry, 1991; Rowe and Gates, 1995; Richmond, 2002; Rowe and Richmond, 2004), South Africa (Mbongwa, 2013).

Ecology
Depth range: 0-33m (Koehler, 1905a; Rowe and Gates, 1995).
Habitat: Associated with sponges, coral bases and sea grass beds, algae.

Remarks
In KZN, this species appears to be associated with the six-armed species *Ophiactis savignyi* found in and among rocky shore algae scrapings.

According to Rowe and Gates (1995), the type locality is Mergui Archipelago, Burma (Myanmar).

Ophiomastix koehleri Devaney, 1977

(Plate 2.4A, B)

Ophiomastix koehleri Devaney, 1977: 274-283, fig. 1-4; Cherbonnier and Guille, 1978: 186-188, pl. 11, figs 1, 2; Sloan *et al.*, 1979: 92, 109, fig. 16; Humpreys, 1981: 10, 25.

Material / Records

RMCA MT2146, -30.2637°, 30.8264°, Aliwal Shoal, depth 15m, August 1999, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn. RMCA MT2161, -27.4472°, 32.7167°, Sodwana Bay, 7-mile Reef, depth 18m, February 2001, collected by Y. Samyn, determined by Y. Samyn and M. Garcia. SAMC A28130, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 25 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28120, -27.5166°, 32.6833°, Sodwana Bay, depth 14m, 23 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers.

Diagnosis *(See Devaney, 1977; Cherbonnier and Guille, 1978)*

D.D. up to 23mm. Disc round and puffy, dorsally disc covered uniformly by short, rounded granules, ventrally disc with similar granules but not extending up to oral shields, leaving a broken wide V-shaped interradial area with scales, dark brown, variegated with whitish grey. Oral shields round with dark patch on each surrounded by white on margin, adoral shields small, not contiguous. Genital slits large, almost reaching disc margin, genital papillae present, extending to oral shields. Dorsal arm plates fan-shaped, much wider than long, convex distally, most often a thin white line bordering the plates, narrowly contiguous. Ventral arm plates fan-shaped with convex distal edges, brown with small grey patch surrounded by white margin. Arm spines three to four on each side of same or mostly adjacent segments, often alternating, uppermost spine markedly longer, cigar-shaped, clavate distally and more or less bifurcate at tip, broadly banded, with bands becoming more obvious distally, up to five times segment length, remaining spines cigar-shaped with blunt tip, greyish bands not always around full circumference of spine, two to three times segment length, shortest being 1.5 times segment length. Tentacle scales two, becoming one after approximately one-third of arm length, oval, similar in size. Colour in life uniformly dark purple, brown, black with white edges, dorsal arm plates off-white with large irregular purple patches, giving arm banded appearance. Upper arm spines pale or purple mottled, clavate, remaining arm spines purple and white annulations, tentacle scales banded, oral shields with large dark purple blotches.

Global distribution

Madagascar, Zanzibar, Kenya, Aldabra, Comoros (Cherbonnier and Guille, 1978), South Africa.

Ecology

Depth range: 0-18m.

Habitat: Under *Porites* coral colonies, over sandy gravel in lagoonal seagrass bed (Sloan *et al.*, 1979).

Remarks

According to Devaney (1977) the type locality is Zanzibar and the holotype is held at the Natural History Museum in London (BMNH 1965-6-1-451). The granules on the ventral interradial area do not extend to oral shields, but the spines originating from the genital slits do extend up to oral shields.

Ophiomastix venosa Peters, 1851
(Plate 2.4C, D)

Ophiomastix venosa Peters, 1851: 464-465; Lütken, 1869: 44; Lyman, 1882: 175; Koehler, 1904b: 73-74, figs 28, 29; Clark, 1915a: 296; Clark, 1921: 134, 138; Clark, 1923: 349; Balinsky, 1957: 27-28; Kalk, 1958: 237; Macnae and Kalk, 1969: 130; Clark and Rowe, 1971: 88, 120; Clark and Courtman-Stock, 1976: 105, 122, 176-177, fig. 191; Devaney, 1978: 279, 350-353, figs 41, 42; Cherbonnier and Guille, 1978: 190-192, pl. 14, figs 1-2, fig. 63; Sloan *et al.*, 1979: 109-111; Tortonese, 1980: 117, 128, fig. 12; Humpreys, 1981: 10, 25.

Material / Records
RMCA MT2353, -27.5227°, 32.7129°, Sodwana Bay, depth 21m, 7 November 2003, collected and determined by Y. Samyn. SAMC A28128, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 25 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. AM J.10517, -31.9839°, 29.1525°, Coffee Bay, depth unknown, collection date 1974.

Diagnosis *(See Clark and Courtman-Stock, 1976; Cherbonnier and Guille, 1978; Devaney, 1978)*
D.D. up to 31mm. Disc round and puffy, dorsal disc scales fine, light brown, pair of radiating dark brown lines outlined in white starting from base of each arm and meandering in random pattern. Ventral disc scales lighter brown and coarser in proximal interradial areas, some ovate imbricated scales delimiting periphery of disc. Granules sparsely scattered on both dorsal and ventral sides of disc, with scattered cylindrical spines towards margin of dorsal disc. Radial shields visible, but not distinct. Genital slits large, reach margin of disc, genital papillae absent. Oral shields slightly wider than long, adoral shields triangular, largely separated. Arm spines two to four, alternating in number, cigar-shaped, but tapering with darker longitudinal line; on every two to three segments, upper arm spine enlarged and has clavate, cloven or digitate tip, *c.* 3.5-4 times segment length, longitudinal line absent on largest spines, other arm spines approximately two times segment length. Dorsal arm plates broadly fan-shaped, wider than long, broadly contiguous, becoming slightly longer than wide, narrowly contiguous. Ventral arm plates pentagonal but truncated, distal side straight or convex, lateral sides may be concave. Tentacle scales two basally, distally one, ovate. Colour in life, disc light brown with radiating lines on disc, radial shields with black petaloid pattern (Humpreys, 1981), arm spines with longitudinal dark stripe, dorsal arm plates brownish with a darker faded line down length of arm, ventrally uniformly light brown.

Global distribution
Aldabra, Kenya, Mascarene Basin, Mozambique, Rodriguez, Seychelles, Somalia, Tanzania, Philippines, Madagascar, Comoros, Bay of Bengal, tropical Indo-Pacific (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Devaney, 1978; Tortonese, 1980), South Africa.

Ecology
Depth range: 0-21m.
Habitat: Found in shallow lagoons, often on sand and rubble, algal carpet, under boulders, coral heads, and *Porites* in lagoonal seagrass beds (Sloan *et al.*, 1979), may be in same habitat with *Ophiocoma scolopendrina* (Lamarck, 1816) (Balinsky, 1957).

Remarks
Clark and Courtman-Stock (1976) recorded this species in Mozambique. Type locality is Mozambique.

Family OPHIOTRICHIDAE Ljungman, 1867

***Macrophiothrix demessa* (Lyman, 1862)**
(Plate 2.4E, F)

Ophiothrix demessa Lyman, 1862: 82; 1865: 172-173; Marktanner-Turneretscher, 1887: 310; Brock, 1888: 513; Koehler, 1905a: 91-92, pl. 9, figs 5, 6; Clark, 1915a: 270; Clark, 1921: 109; Clark, H.L., 1939: 83.
Ophiothrix mauritiensis De Loriol, 1893a: 38, pl. 24, fig. 5.
Ophiothrix coronata Koehler, 1905a: 91, pl. 9, figs 8, 9; Koehler, 1922b: 217-218, pl. 40, fig. 5, pl. 41, figs 1-4, pl. 98, fig. 1; Koehler, 1930: 137; Vine, 1986: 195.
Amphiophiothrix demessa: Clark, 1946: 217; Endean, 1957: 243; Fell, 1960: 24.
Macrophiothrix mossambica Balinsky, 1957: 18, fig. 7, pl. 3, figs 11-12.
Macrophiothrix demessa: Clark, 1968: 289-291, figs 3e, f, 4h, 5h, 7e; Clark and Rowe, 1971: 82, 114, pl. 37f; Devaney, 1974: 139-140; Clark and Courtman-Stock, 1976: 111, 138, fig. 114; Sloan *et al.*, 1979: 102-103; Cherbonnier and Guille, 1978: 151-152, pl. 4,figs 1, 2; fig. 61: 7-9; Sastry, 1991: 374, 377, pl. 3, fig. 16; Milne, 2012: 155.

Material / Records
RMCA MT2156, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 13m, 4 September 1999, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2154, -30.2637°, 30.8264°, Aliwal Shoal, depth 16m, 15 August 1999, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. RMCA MT2166, -26.9335°, 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, collected by Y. Samyn, determined by M. Garcia and Y. Samyn. SAMC A74052, -27.5396°, 32.6804° Sodwana Bay, depth unknown, 15 October 2010, collected by R. Milne, ACEP II, determined by J.M. Olbers. SAMC A28145, -29.5500°, 31.4167°, Ballito, depth 60-64m, 7 June 1988, *Meiring Naude*, station number XX131, Natal Museum Dredge, determined by J.M. Olbers. EKZNW LR_3_ME_2008, -27.7167°, 32.6501°, NE of Liefeldt's Rocks, depth 50m, 8 June 1988, *Meiring Naude*, Natal Museum Dredge, determined by J.M. Olbers.

Diagnosis *(See Clark and Courtman-Stock, 1976; Cherbonnier and Guille, 1978)*
D.D. up to 12mm. Disc puffy, covered dorsally with long thorny stumps, two to six terminal points, ventrally covered with similar stumps, but more scattered and typically with single terminal points. Radial shields triangular, two-thirds length of disc radius, covered with shorter and less numerous stumps than those on disc. Jaws elongated, oral shields broadly triangular, much wider than long. Adoral shields not contiguous. Genital slits half-way to disc, genital plate large, adjacent to slit, with disc spinelets not continuing to edge of genital slit. Dorsal arm plates broadly fan-shaped, about twice as wide as long or wider, broadly in contact, armed with small rugose granules or sparse stumps. Ventral arm plates wide, fan-shaped, but with rounded proximal edges, as long as wide, sometimes slightly longer than wide, contiguous. Arm spines up to 14, thorny over entire length, glassy, longest spine at least three times segment length, shortest ventrally. Tentacle scale one, triangular. Colour in life, dorsal side of disc greyish, with more or less conspicuous dark pink spots, ventrally lighter and fewer spots. Arms banded purple, pink or red with white dorsally and lighter ventrally, with two to three arm segments between bands.

Global distribution
Tropical Indo-West Pacific, Australia, Hawaiian Islands, Mozambique, Mauritius, Zanzibar, Red Sea, India, Seychelles, Maldive Islands, Philippines, China Sea (Clark and Rowe, 1971; Hoggett, 1991; Sastry, 1991; Rowe and Gates, 1995), South Africa (Milne, 2012).

Ecology
Depth range: 0-128m.

Habitat: Concealed in coral, deep rocky crevices, under stones with coarse sand and with *Lithothamnion* (Hoggett, 1991).

Remarks
Recorded from Mozambique in Clark and Courtman-Stock (1976). According to Rowe and Gates (1995) the type locality is in the Hawaiian Islands (recorded as Sandwich Islands). Specimens are held at the Museum of Comparative Zoology (holotype: MCZ OPH-2278; paratypes: MCZ OPH-2279, MCZ OPH-2280, MCZ OPH-2281 and MCZ OPH-4095).

***Macrophiothrix propinqua* (Lyman, 1862)**
(Plate 2.5A, B)

Ophiothrix propinqua Lyman, 1862: 83-84; Lyman, 1874: 234; Ljungman, 1867b: 333; Marktanner-Turneretscher, 1887: 308; Brock, 1888: 510; Koehler, 1898b: 98-100, pl. 3, figs 20-22; Koehler, 1905a: 81; Clark, 1915a: 277; Clark, 1921: 113; Koehler, 1922b: 256-257, pl. 38, figs 1-2, pl. 101, fig. 4; Murakami, 1943b: 207-208.
Ophiothrix triloba Von Martens, 1870: 260-261.
Ophiothrix bedoti De Loriol, 1893a: 420-422, pl. 15, fig. 1.
Ophiothrix schmidti Djakonov, 1930: 237-239, pl. 12: 1, 2.
Ophiotrichoides propinqua: Clark, 1946: 232; Balinsky, 1957: 21; Endean, 1957: 244.
Macrophiothrix schmidti: Clark, 1966: 649.
Ophiothrix (*Keystonea*) *propinqua*: Clark, 1966: 648; Clark, 1968: 283, fig. 2e; Clark and Rowe, 1971: 86-87, 107; Clark and Courtman-Stock, 1976: 102, 111, 145; Gibbs *et al.*, 1976: 127; Cherbonnier and Guille, 1978: 149, pl. 5, figs 1, 2, fig. 61: 11, 12; Sloan *et al.*, 1979: 103; Guille and Wolff, 1984: 6.
Ophiothrix (*Placophiothrix*) *westwardi* Devaney, 1974: 143-148, figs 8-14.
Macrophiothrix propinqua: Clark, 1980: 537; Guille and Vadon, 1985: 62; Hoggett, 1991: 1130-1133, figs 28, 29; Sastry, 1991: 378, pl. 3, fig. 18; Milne, 2012: 155.

Material / Records
RMCA MT2216, -27.5227°, 32.6919°, Sodwana Bay, depth unknown, 10 April 1999, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. RMCA MT2261, -30.2637°, 30.8264°, Aliwal Shoal, depth 20m, 14 August 1999, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. SAMC A28123, SAMC A28124, and SAMC A28126, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 24 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28134, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 25 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. EKZNW SB_1_ME_2008, -27.5227°, 32.6919°, Sodwana Bay, depth 10-15m, 12 September 1987, *Meiring Naude*, Natal Museum Dredging Programme, collected by D. Herbert, R. Broker and M. Mander, determined by J.M. Olbers. SAMC A74051, -27.5396°, 32.6804°, Sodwana Bay, depth unknown, 15 October 2010, ACEP II, collected by R. Milne, determined by J.M. Olbers. SAMC A74055, -27.5230°, 32.6920°, Sodwana Bay, depth 7.5m, 15 October 2010, ACEP II, collected by R. Milne, determined by J.M. Olbers. SAMC A74039, -26.9002°, 32.9180° SE of Kosi Bay, depth 50m, 3 June 1990, *Meiring Naude*, station number ZA37, Natal Museum Dredging Programme, determined by J.M. Olbers. EKZNW SX_10_2014, -26.9266°, 32.8866°, Saxon Reef, depth 9m, 4 December 2014, collected by J.M. Olbers, determined by J.M. Olbers.

Diagnosis *(See Clark and Courtman-Stock, 1976; Cherbonnier and Guille, 1978)*
D.D. up to 12mm. Disc round, puffy, scales clearly visible, with or without armament. Radial shields large, more than half disc radius, naked, disc scales in single or multiple rows between radial shields, some with tubercles or spines. Ventral interradial areas with tubercles, but somewhat sharper than

dorsal ones. Oral shields diamond-shaped, wider than long, adoral shields sometimes touching. Genital slits narrow, reaching margin of disc, genital papillae absent, genital plate conspicuous. Dorsal arm plates fan-shaped to elliptical, much wider than long, especially distally, with proximal edge short, distal edge slightly trilobed, broadly contiguous for more than one-third of their breadth, some proximal-most plates contain point on distal end. Ventral arm plates square and slightly wider than long, most often with slight distal notch. Arm spines up to eight, finely serrated over total length or apices of spines, orientated proximally, glassy, longest two times longer than segment length, shortest on ventral side. Tentacle scale one, large, oval. Colour in life pink, purple with patterns on disc, arms banded every three to four segments. Radial shields reddish, sometimes with blue patches, distal edge outlined with white.

Global distribution

Tropical Indo-West Pacific, India, Aldabra, Comoros, Madagascar, Kenya, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, Somalia, Tanzania, Western Indian Ocean (Rowe and Gates, 1995; Richmond, 2002), South Africa (Milne, 2012).

Ecology

Depth range: 0-80m.
Habitat: Associated with coral, coral slabs, in crevices.

Remarks

In 1966, A.M. Clark, designated *propinqua* to *Ophiothrix* (*Keystonea*), but in 1980, she transferred it to *Macrophiothrix* because of their similarities in arm and internal jaw structures. *M. propinqua* is easily recognised from other *Macrophiothrix* species due to its smaller size, radial shields always naked except for a few stumps near edges and arm spines that are shorter than in other *Macrophiothrix* species.

According to Rowe and Gates (1995), the type locality is Kiribati (as Kingsmill Ils) with the holotype held at the Museum of Comparative Zoology (MCZ OPH-2399).

***Ophiothrix (Acanthophiothrix) purpurea* Von Martens, 1867**

(Plate 2.5C, D)

Ophiothrix purpurea Von Martens, 1867a: 346; Döderlein, 1896: 296, pl. 14, fig. 12, pl. 17, figs 23-23a; Koehler, 1905a: 102; Clark, 1915a: 277; Koehler, 1922b: 261, pl. 58, figs 3-4, pl. 101, fig. 6; Vine, 1986: 195.
Ophiothrix fallax De Loriol, 1893a: 47-48, pl. 25, fig. 2.
Ophiothrix lorioli Döderlein, 1896: 297, pl. 14, figs 13a, b, pl. 17, fig. 24a, b.
Placophiothrix purpurea: Clark, H.L., 1939: 86-87; Clark and Spencer Davis, 1966: 599.
Ophiothrix (*Acanthophiothrix*) *purpurea*: Clark and Rowe, 1971: 86-87, 112, figs 35d, 36, pl. 15, figs 4, 11; Devaney, 1974: 141-142; Cherbonnier and Guille, 1978: 148-149, pl. 5, figs 5-6, fig. 61: 5-6; Sloan *et al.*, 1979: 103; Rowe and Gates, 1995: 424-425; Humpreys, 1981: 23; Price and Rowe, 1996: 75; Putchakarn and Sonchaeng, 2004: 422; Guille and Vadon, 1985: 63.

Material / Records

RMCA MT2185, -27.5227°, 32.6919°, Sodwana Bay, depth 12m, 8 April 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2211, -27.5227°, 32.6919°, Sodwana Bay, depth 16m, 15 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2288, -27.5227°, 32.6919°, Bhanga Nek, depth 15m, 10 September 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia.

RMCA MT2289, -26.9335°, 32.8871°, Bhanga Nek, depth 29m, 16 August 1999, SCUBA, collected by Y. Samyn, P. Timm and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. RMCA MT2357, -27.5227°, 32.6919°, Sodwana Bay, depth unknown, 19 February 2003, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. SAMC A28122, RW7614_1, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 24 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. EKZNW SB_2_ME_2008, -27.5333°, 32.6910°, Sodwana Bay, depth 13m, 6 July 1987, SCUBA, collector G. Williams, determined by J.M. Olbers. Data Record EchinoMAP 445, -27.5265°, 32.6822°, Sodwana Bay, Bikini Reef, depth unknown, 10 May 2013, photographed and determined by C. Griffiths and G. Jones.

Diagnosis *(See Clark and Rowe, 1971; Cherbonnier and Guille, 1978)*
D.D. up to 17mm. Disc pentagonal, dorsally scaled with armament of scattered tubercles and spinelets (long and short) interradially and between radial shields, smaller spinelets on disc margin. Disc ventrally with small spinelets. Radial shields triangular, naked, large, about two-thirds disc radius, more or less conspicuous dark purple stripe along proximal edge, central area more or less variegated whitish and purple, proximal edge concave. Oral shields elliptical, with sharp point on proximal side, much wider than long. Adoral shields contiguous. Genital slits almost to margin, with genital plate from about half-way. Dorsal arm plates hexagonal, distal side convex, as long as wide or longer, consecutive plates in contact for less than one-third of their widths. Ventral arm plates somewhat fan-shaped, distal side concave, proximal edge convex becoming straight, as long as or longer than wide. Arm spines up to seven, mostly five, glassy, upper spines smooth becoming serrated, up to five times segment length, lower spines shorter and more serrated, lowest arm spine often very short with hooks. Tentacle pores large. Tentacle scale one, small, pointed. Colour in life dorsally reds, pinks and whites, some with striking lines, arms have thin dark longitudinal line along length of arm both dorsally and ventrally, dorsal arm plates with some lateral whitish patches.

Global distribution
Aldabra, Madagascar, Mascarene Basin, Red Sea, Seychelles, Tanzania, Western Indian Ocean, Australia (Rowe and Gates, 1995; Stöhr *et al.*, 2014), South Africa.

Ecology
Depth range: 5-508m (Rowe and Gates, 1995).
Habitat: Epizoic on *Millepora* spp., soft corals, gorgonians and crinoids (Sloan *et al.*, 1979; Price and Rowe, 1996).

Remarks
Specimens were consistent with descriptions given by Cherbonnier and Guille (1978) and Clark and Rowe (1971). Most distinctive feature of this species is the dark longitudinal lines on both dorsal and ventral arms. Type locality is Amboina, Indonesia (Rowe and Gates, 1995).

Ophiothrix (Ophiothrix) echinotecta Balinsky, 1957
(Plate 2.5E, F)

Ophiothrix (*Ophiothrix*) *echinotecta* Balinsky, 1957:16-17, fig. 6, pl. 3, figs 9-10; Kalk, 1958: 198; Macnae and Kalk, 1969: 99, 106, 129; Clark and Rowe, 1971: 84-85, 109; Clark and Courtman-Stock, 1976: 112, figs 112, 116, 101, 143; Tortonese, 1980: 122; Humpreys, 1981: 23.
Ophiothrix echinoteta: Mbongwa, 2013: 16 (*lapsus calami*).

Material / Records

RMCA MT2257, -27.9335°, 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. SAMC A28118, SAMC A28125, SAMC A28129, SAMC A28131, SAMC A28135, -27.5166°, 32.6833°, Sodwana Bay, depth 14-15m, 23 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28137, SAMC A28138, SAMC A28139, -27.2225°, 32.7966°, Island Rock, depth unknown, 28 July 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28141, -27.5166°, 32.6833°, Sodwana Bay, depth 14m, 1 August 1976, SCUBA, J.L.B. Smith Institute, determined by J.M. Olbers. SAMC A28146, -29.5500°, 31.4167°, Ballito, depth 60-64m, 7 June 1988, dredge, *Meiring Naude*, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A28147, -27.5338°, 31.3188°, SE of Sheffield Beach, depth 50m, 1 June 1990, dredge, *Meiring Naude*, station number XX153, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74049, -28.5167°, 32.4333°, off Cape St Lucia, depth 55m, 12 June 1988, *Meiring Naude*, station number ZO6, dredge, Natal Museum Dredging Programme, determined by J.M. Olbers. Data Record Mbongwa, 2013, -29.9997°, 30.9450°, Isipingo, intertidal, 13 March 2013, collected by N.A. Mbongwa, determined by J.M. Olbers.

Diagnosis *(See Clark and Courtman-Stock, 1976)*

D.D. up to 8mm. Disc round, covered with stumps with density on radial shields being slightly less, stumps bicuspid, tricuspid and multifid, stumps reaching ventral interradial areas. Radial shields length about half disc radius, some scattered short stumps, fewer than rest of disc. Oral shields diamond-shaped, twice as wide as long. Adoral shields narrow and contiguous. Genital slits reaching half-way up to margin with distinct genital plate adjacent to slit. Dorsal arm plates fan-shaped, single rugose, short stump on distal point on many plates, narrowly contiguous. Ventral arm plates slightly broader than long with straight or slightly concave distal edge. Arm spines up to ten, serrated for total length, glassy, middle spine longest, approximately three times segment length, upper spines shorter with uppermost spines being short stumps, lowermost being transformed into a hooks. Tentacle scale one, small, may bear one or two sharp points at tip. Colour in life, dorsal disc light and dark greens, greys and blues. Radial shields variegated white and green, slightly darker than remaining disc, dorsal arm plates sometimes with dark transverse line or chevron on distal side. Ventral side slightly lighter.

Global distribution

Madagascar, Kenya, Mozambique, Somalia, Tanzania (Balinsky, 1957; Clark and Rowe, 1971; Tortonese, 1980; Humpreys, 1981), South Africa (Mbongwa, 2013).

Ecology

Depth range: 0-64m.

Habitat: Found in rock hollows and under echinoids *Echinometra mathaei* and *Stomopneustes variolaris* (Balinsky, 1957). May also be found on coarse sand, gravel, shell debris, stones and sponges.

Remarks

Probably the easiest South African *Ophiothrix* species to identify, due to a rugose stump present on many of the dorsal arm plates. Type locality is at Lighthouse Rocks, Inhaca Island, Mozambique. Type specimens are held at the Iziko South African Museum (holotype SAMC A22355 and paratypes SAMC A22356).

Ophiothrix (Ophiothrix) foveolata Marktanner-Turneretscher, 1887

(Plate 2.6A, B)

Ophiothrix foveolata Marktanner-Turneretscher, 1887: 313, pl. 13, figs 32, 33; Koehler, 1905a: 76-77; Clark, 1915a: 280; Koehler, 1922b: 238-239, pl. 47, figs 4-7, pl. 98, fig. 6; Koehler, 1930: 140; Clark and Spencer Davis, 1966: 599; Clark, 1966: 647; Clark and Rowe, 1971: 84, 85, 110, pl. 15, fig. 3; Day, 1974: 94; Putchakarn and Sonchaeng, 2004: 423; Mbongwa, 2013: 16.
Ophiothrix insidiosa Koehler, 1898b: 92-93, pl. 4, figs 34-36.
Ophiothrix poecilodisca Clark, 1915a: 276, pl. 13, fig. 5; Clark, 1923: 341.
Placophiothrix foveolata: Balinsky, 1957: 20, pl. 4, fig. 15; Kalk, 1958: 207, 214; Macnae and Kalk, 1962: 111; Macnae and Kalk, 1969: 102, 106, 130.
Ophiothrix (*Ophiothrix*) *foveolata*: Day, 1969: 184; Clark and Courtman-Stock, 1976: 101, 112, 143-144, fig. 118.

Material / Records

RMCA MT2174, -27.4132°, 32.7268°, Sodwana Bay, 9-mile Reef, depth 18m, 12 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. EKZNW SB_1_JMO_2009, -27.5361°, 32.6851°, Sodwana Bay, depth 9m, 8 December 2009, SCUBA, collected and determined by J.M. Olbers. SAMC A28148, -30.0686°, 31.0508° Amanzimtoti, depth 300-305m, 9 July 1985, dredge, *Meiring Naude*, station number XX66, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74040, -26.8667°, 32.9168° NE of Kosi Bay, depth 51-53m, 3 June 1990, dredge, *Meiring Naude*, station number ZA40, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74044, -27.5188°, 32.7022°, off Sodwana Bay, depth 77m, 2 June 1990, dredge, *Meiring Naude*, station number ZH18, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74045, -27.5168°, 32.7166°, off Sodwana Bay, depth 70m, 2 June 1990, dredge, *Meiring Naude*, station number ZH22, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74046, -27.5502°, 32.7069°, SE of Sodwana Bay, depth 70m, 2 June 1990, dredge, *Meiring Naude*, station number ZH23, Natal Museum Dredging Programme, determined by J.M. Olbers. SAMC A74048, -27.7500°, 32.6502°, off Gypsea Hill, depth 110m, 8 June 1988, dredge, *Meiring Naude*, station number ZK4, Natal Museum Dredging Programme.

Diagnosis *(See Clark and Courtman-Stock, 1976)*

D.D. up to 13mm. Disc round, mostly naked, covered in scales and some scattered small granules, though peripherally some scattered large trifid stumps, disc scales moderately large. Radial shields triangular, naked, more than two-thirds disc radius, single row of scales between radial shields. Oral shields broad diamond-shaped, much wider than long. Adoral shields moderate in size, may or may not be contiguous. Genital slits half-way to disc margin, genital papillae absent, distinct genital plate. Dorsal arm plates fan-shaped, distal edge convex, consecutive plates in contact for less than half their width. Ventral arm plates square or rectangular, wider than long, distal edge concave, proximal edge slightly convex or straight. Arm spines up to eight, glassy, serrated, longest four to five times segment length, some spines with dark longitudinal bands and some with clavate tips. Tentacle scale one, small, tapering. Colour in life ranging from orange, light brown to violet, young specimens may be bright red, radial shields whitish, patterned with dark purple lines and pinkish patches, adradial edges of radial shields may have dark lines. Arms transversed with same striking dark lines as on disc.

Global distribution

Madagascar, Mozambique, Thailand (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Clark, 1980; Putchakarn and Sonchaeng, 2004; Stöhr *et al.*, 2014), South Africa.

Ecology
Depth range: 9-305m.
Habitat: Coral reefs, under dead coral blocks, rock crevices and in *Cymodocea* beds (Day, 1969; Clark and Courtman-Stock, 1976).

Remarks
Quite similar to *M. propinqua*, but radial shield size is a useful character to distinguish between species. According to Rowe and Gates (1995), the type locality is Aru Islands, Indonesia.

Family OPHIACANTHIDAE Ljungman, 1867

***Ophiotoma* cf. *alberti* (Koehler, 1896a)**
(Plate 2.6C, D)

Ophiotrema alberti Koehler, 1896a: 251; Koehler, 1906: 6; Koehler, 1907: 324; Koehler, 1908a: 612; Koehler, 1909b: 196-198; Matsumoto, 1915: 62; Koehler, 1922b: 90; Mortensen, 1927: 183; Gage *et al.*, 1983: 288; Paterson, 1985: 57-58, fig. 3; Smirnov *et al.*, 2014: 197.
Ophiotoma alberti: Madsen, 1951: 113; O'Hara and Stöhr, 2006: 75; Martynov, 2010: 18, 92, 97-103, 126, 131, fig. 66A-E, fig. 67A, fig. 68, figs 6C, H, fig. 13C, E, F, fig. 18L, fig. 28B.

Material / Records
SAMC A22112, -33.8116°, 16.5000°, off Saldanha Bay, depth 2730m, 27 August 1959, trawl, *Africana II*, station number A193, determined by A.M. Clark.

Diagnosis *(See Paterson, 1985; Martynov, 2010)*
D.D. up to 17mm. Disc with small scales, scattered spinelets also extending onto ventral interradial areas. Radial shields naked, sometimes visible, rounded pear-shaped. Oral papillae four or five, in continuous series with two scales in oral tentacle pores. Oral shield large, wider than long, nearly D-shaped with rounded proximal edge and slight distal lobe. Adoral shields wing-like, proximal edge indented opposite second oral tentacle pore. Dorsal arm plates triangular to bell-shaped, twice as wide as long, nearly contiguous. Ventral arm plates rectangular with obtuse proximal angle and slight indent on distal edge, nearly contiguous on proximal arm. Arm spines four, glassy, smooth, slightly flattened, rounded tip, uppermost longest, up to two segments in length. Tentacle pores large. Tentacle scales needle-like or round, variable, small if not absent, number from zero to five.

Global distribution
Rockall Trough, Bay of Biscay, Azores, north eastern Atlantic (Paterson, 1985), South Africa (A.M. Clark, unpublished data).

Ecology
Depth range: 1862-4354m (Smirnov *et al.*, 2014).
Habitat: No information available.

Remarks
A single specimen is catalogued in the SAMC collection, identified by A.M. Clark but for reasons unknown not included in the monograph by Clark and Courtman-Stock (1976). According to Paterson (1985), the type locality is North Atlantic Ocean and the type is held at the Natural History Museum in Paris (MNHN).

Ophiotoma cf. *gracilis* (Koehler, 1914)

(Plate 2.6E, F)

Ophiotrema gracilis Koehler, 1914a: 112-114, pl. 12, figs 1, 2; Paterson, 1985: 54, 58, fig. 23; Borrero-Perez *et al.*, 2008: 181, fig. 7I.
Ophiotoma gracilis: Martynov, 2010: 98, 103, 141.

Material / Records

SAMC A22103, -34.6166°, 17.0500°, off Cape Town, depth 2875-2948m, 8 December 1959, trawl, *Africana II*, station number A315, determined by A.M. Clark.

Diagnosis *(See Paterson, 1985; Martynov, 2010)*

D.D. up to 11mm. Disc with small scales, scattered spinelets also extending onto ventral interradial areas, but not up to oral shields. Radial shields naked, elongated triangular, rounded distal margin, separated but diverging. Oral papillae five, conical, in a continuous series with two scales in oral tentacle pores, which are more elongated, almost spiniform. Oral shield large, much wider than long, spearhead-shaped, with distinct distal lobe. Adoral shields elongated, contiguous. Genital slits narrow. Dorsal arm plates triangular, distal edge convex, almost as long as wide, not contiguous. Ventral arm plates pentagonal, proximal edge concave and obtuse, lateral edges excavated by tentacle pores, much longer than wide, not contiguous. Arms relatively slender. Arm spines four, fine, smooth, pointed, uppermost longest, up to 1.5 segments in length. Tentacle pores large. Tentacle scales subequal, five or six, spinose.

Global distribution

Lesser Antilles and Colombia (Borrero-Perez *et al.*, 2008), South Africa (A.M Clark, unpublished data).

Ecology

Depth range: 490-2948m (Borrero-Perez *et al.*, 2008; A.M. Clark, unpublished data).
Habitat: No information available.

Remarks

A single specimen is catalogued in the SAMC collection and was identified by A.M. Clark (date unknown), but for unknown reasons not reported in the monograph by Clark and Courtman-Stock (1976). Prior to the study by Borrero-Perez *et al.* (2008), the holotype was the only known specimen.

A number of differences occur between *Ophiotoma alberti* and *O. gracilis*. In *O. gracilis,* the arms are more slender, arm spines finer, dorsal arm plates narrower, smaller and more widely separated, ventral arm plates longer, the oral tentacle pore scales are different in size and shape to the oral papillae and the oral shield is spearhead-shaped. The tentacle scales in *alberti* are smaller and while in *gracilis* they are spinose they are more obvious. On the specimen at hand (SAMC A22103), the arm spines are missing.

According to Borrero-Perez *et al.* (2008) the type locality is Lesser Antilles and the type is held at the Smithsonian Institution (USNM 32301), depth 1256m (Koehler, 1914a).

Family OPHIODERMATIDAE Ljungman, 1867

Ophiochaeta hirsuta Lütken, 1869

(Plate 2.7A, B)

Ophiochaeta hirsuta Lütken, 1869: 38, 71; Clark, 1915a: 222; Clark and Rowe, 1971: 127, fig. 44a, b; Gibbs *et al.*, 1976: 129; Sloan *et al.*, 1979: 115; Marsh *et al.*, 1993: 62; Rowe and Gates, 1995: 398; Price and Rowe, 1996: 78.
Ophiochaeta boschmai Clark, 1964: 388-340, fig. 2.

Material / Records

RMCA MT2307, -27.5227°, 32.6919°, Sodwana Bay, depth unknown, 10 August 1999, SCUBA, collected by Y. Samyn, determined by Y. Samyn and M. Garcia. RMCA MT2293, -26.9335°, 32.8871°, Bhanga Nek, depth 29m, 14 August 1999, SCUBA, collected by Y. Samyn, P. Timm and E. Vanden Berghe, determined by Y. Samyn and M. Garcia. RMCA MT2290, RMCA MT2291, -27.5227°, 32.6919°, Sodwana Bay, depth 8-24m, 8-10 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by Y. Samyn and M. Garcia.

Diagnosis *(See Clark and Rowe, 1971; Sloan et al., 1979)*

D.D. up to 7mm. Disc pentagonal, completely covered in indented granules and long, thin spinelets both dorsally and ventrally, spinelets densest on ventral interradials close to oral shields. Oral shields and adoral shields may have granules, but few if present. Radial shields concealed by granulation and spinelets. Marginal plates covered by rounded and enlarged granules, disc spines dense on disc margin. Genital slits single, up to half-way to margin, genital papillae absent. Oral shields triangular, slightly longer than wide; no supplementary oral shields. Adoral shields large, triangular, not contiguous. Oral papillae five to six, pointed. Teeth three, lowermost bluntly pointed, second square and uppermost pointed. Dorsal arm plates triangular, distal edge straight, proximally narrowly contiguous, distally not contiguous. Ventral arm plates pentagonal, distal edge straight or somewhat convex. Arm spines up to 12, tapering, subequal, all shorter than one segment length. Tentacle scales oval, two proximally, but one along most of arm. Colour in life grey to brown, mottled, arms banded with dark brown, light brown and white.

Global distribution

Indo-Malayan region, Western Indian Ocean, Aldabra, Australia, South Pacific Islands, Red Sea (Clark and Rowe, 1971; Rowe and Gates, 1995; Richmond, 2002), South Africa.

Ecology

Depth range: 0-26m (Rowe and Gates, 1995).
Habitat: Associated with *Porites* coral colonies or on sandy gravel in lagoonal sea grass beds (Sloan *et al.*, 1979).

Remarks

All specimens from South Africa are housed in the RMCA and are consistent with descriptions given by Clark and Rowe (1971). Type locality is Fiji Islands (Clark, 1915a). Rowe and Gates (1995) suggested the type material may be in the Natural History Museum of Denmark, but upon investigation, this was found not to be the case (Tom Schiøtte, pers. comm.).

Ophioconis cupida Koehler, 1905

(Plate 2.7C, D)

Ophioconis cupida Koehler, 1905a: 15-16, pl. 1, figs 19, 20; Clark and Rowe, 1971: 88-89, 127; Cherbonnier and Guille, 1978: 222-223, pl. 16, figs 3, 4; Vine, 1986: 195; Rowe and Gates, 1995: 399.
Ophiurodon cupida: Matsumoto, 1915: 84; Matsumoto, 1917: 315.
Ophiurodon cupidum: Koehler, 1930: 278; Clark, H.L., 1939: 95-96; Murakami, 1943b: 213; Clark, 1946: 255.

Material / Records

SAMC A74041, -26.8669°, 32.9167°, NE of Kosi Bay, depth 49m, 3 June 1990, dredge, *Meiring Naude*, station number ZA41, Natal Museum Dredging Programme, determined by J.M. Olbers.

Diagnosis *(See Cherbonnier and Guille, 1978)*

D.D. up to 4mm. Disc pentagonal, almost completely covered in granules both dorsally and ventrally. Radial shields concealed by granulation. Oral shields triangular, wider than long; supplementary oral shields present, but concealed by granulation. Adoral shields relatively large, triangular, not contiguous. Oral shields and adoral shields may have granules, but easily rubbed off. Oral papillae five to six, pointed. Teeth three, lowermost wide, large, square, edges translucent. Genital slits single, almost up to disc margin, genital papillae absent. Dorsal arm plates fan-shaped with distal point, narrowly contiguous. Ventral arm plates pentagonal, distal edge pointed, narrowly contiguous. Arm spines up to eight, tapering, subequal, longest one slightly longer than segment length. Tentacle pores moderately large. Tentacle scales one, elongated oval, translucent. Colour grey or white with large brown patches on radial areas, arms banded with brown.

Global distribution

Australia, Bay of Bengal, Comoros, Red Sea, Madagascar, Philippines, China, Japan, Pacific Islands (Cherbonnier and Guille, 1978; Rowe and Gates, 1995), South Africa.

Ecology

Depth range: 10-600m (Rowe and Gates, 1995).
Habitat: Found among sand, kelp and stones.

Remarks

Easily recognisable within the family by the translucent teeth and tentacle scales. According to Rowe and Gates (1995), the type locality is Moluccas and Sulu Archipelago (Indonesia) with the syntypes held at the Naturalis (ZMA.ECH.O 2004, ZMA.ECH.O 2005 and ZMA.ECH.O 2035; Joke Bleeker, pers. comm.).

Ophiodyscrita acosmeta H.L. Clark, 1938

(Plate 2.7E, F)

Ophiodyscrita acosmeta Clark, 1938: 356-357; Clark, 1946: 265; Clark and Rowe, 1971: 88-89, 128; Rowe and Gates, 1995: 399; Price and Rowe, 1996: 79; Lane *et al.*, 2000: 483; Marsh and Morrison, 2004: 295, 298, 302, 306, 312, 337.
Ophiocryptus pacificus Murakami, 1943a: 188-189, fig. 10.
Ophiostegastus compsus Clark, 1968: 317-321, fig. 10.

Material / Records

RMCA MT2183, -27.4472°, 32.7167°, Sodwana Bay, 7-mile Reef, depth 23m, July 2000, SCUBA, collected by Y. Samyn and I. Tallon, determined by F.W.E. Rowe and J.M. Olbers. RMCA MT2184, -

27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 16m, August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by F.W.E. Rowe and J.M. Olbers.

Diagnosis *(See Clark, 1938)*
D.D. up to 8mm. Disc round to pentagonal, covered with small, slightly-indented granules completely covering dorsal and ventral side. Granules on oral shields, adoral shields, supplementary oral shields and dorsal, ventral and lateral arm plates. Radial shields also concealed, some granules slightly enlarged over marginal area. Oral shields ovate to spearhead-shaped, wider than long. Oral papillae six to seven, flattened. Genital slit up to two-thirds to margin of disc. Arms slightly flattened. Dorsal arm plates D-shaped, twice as wide as long, with rounded distal edge, with two more-or-less conspicuous whitish patches on distal edge of each plate, covered with granules similar to those on disc. Ventral arm plates more or less rhombic, becoming bell-shaped with distal edges round, not contiguous distally. Lateral arm plates slightly projecting. Arm spines up to eight, appressed, short, less than half segment length. Tentacle scales ovate, up to three basally, inner one largest, two becoming one toward distal segments of arm. Colour in life dorsally brown and grey, ventrally lighter, dorsal disc patchy light and dark. Arms banded with darker bands of three to five segments.

Global distribution
Japan, China and Australia (Clark and Rowe, 1971), South Africa.

Ecology
Depth range: 0-23m.
Habitat: No detail recorded.

Remarks
Type locality is Broome, Western Australia with the holotype at the Museum of Comparative Zoology (MCZ OPH-5294) (Clark, 1938).

Ophiopeza spinosa (Ljungman, 1867)
(Plate 2.8A, B)

Ophiarachna spinosum Ljungman, 1867b: 305.
Ophiopeza dubiosa: Clark, 1968: 313.
Ophiopeza fallax: Lütken, 1869 (non Peters, 1851): 35.
Ophiopeza spinosa: Clark and Rowe, 1971: 90-91, 127, fig. 44e; Gibbs *et al.*, 1976: 130; Cherbonnier and Guille, 1978: 227-228, pl. 17, figs 3, 4; Tortonese, 1980: 129; Humpreys, 1981: 10; Vine, 1986: 195; Vail and Rowe, 1989: 273-275, fig. 3; Marsh *et al.*, 1993: 62; Rowe and Gates, 1995: 400-401; Mbongwa, 2013: 16.
Pectinura spinosa: Lyman, 1874: 221.
Ophiopezella dubiosa De Loriol, 1893a: 7, pl. 23, fig. 2; Clark, 1909: 120; Clark, 1915a: 304.
Ophiopezella luetkeni De Loriol, 1893b: 392-394, pl. 13, fig. 1.
Ophiopezella spinosa: Clark, 1909: 120; Clark, 1915a: 304; Clark, 1921: 141; Koehler, 1922b: 338-339; Clark, 1946: 258.
Distichophis clarki Ely, 1942: 46-48, fig. 12.

Material / Records
RMCA MT2181, RMCA MT2254, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 8-24m, 9-10 August 1999, SCUBA, collected by Y. Samyn and I. Tallon, determined by Y. Samyn. RMCA MT2284, RMCA MT2296, -26.9335°, 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. SAMC A28119, -27.5166°, 32.6833°,

Sodwana Bay, depth 14m, 23 July 1976, dredge, J.L.B. Smith Institute, determined by J.M. Olbers. EKZNW LS_1_ME_ 2008, -27.8736°, 32.6036°, Leadsman Shoal, depth 9-14m, 14 August 1988, collected by D. Herbert, determined by J.M. Olbers. EKZNW SX_ME_2_2008, -26.9311°, 32.8905°, Saxon Reef, depth 13m, 4 December 2008, collected and determined by J.M. Olbers.

Diagnosis *(See Cherbonnier and Guille, 1978)*
D.D. up to 11mm. Disc pentagonal, covered with dense coat of small indented granules, closely packed up to oral shields, extending onto oral plates or jaws. Disc margin with series of plates in interradial areas. Radial shields concealed by granulation. Oral shields spearhead-shaped, supplementary oral shield not covered by granulation, adoral shields present, relatively large, not contiguous, not distinct, covered in granules. Oral papillae six to seven, elliptical leaf-shaped, pointed but blunt. Teeth four. Genital slits reach half-way to disc margin, genital papillae absent. Dorsal arm plates broadly fan-shaped basally, wider than long, but rounded on distal edge, becoming more typical fan-shaped distally, not contiguous distally. Ventral arm plates bell or fan-shaped, narrowly contiguous. Arm spines up to 12, conical, short, half segment length, slightly longer basally, appressed. Tentacles scales two for most of arm length, inner one large, ovate, almost twice as long as outer one. Colour in life, disc grey to brown yellow, sometimes with patchy patterns, arms banded and marbled.

Global distribution
Somalia, Aldabra, Mascarene Basin, Western Indian Ocean, Kenya, Madagascar, Mozambique, Red Sea, Mauritius, Seychelles, Tanzania, Hawaii, southeast Polynesia (Tortonese, 1980; Rowe and Gates, 1995), South Africa.

Ecology
Depth range: 0-74m (Rowe and Gates, 1995).
Habitat: Found under rocks and coral rubble (Stöhr, 2007e), among mixed algae and on coral reefs.

Remarks
All specimens were consistent with descriptions given by Clark and Rowe (1971) and Cherbonnier and Guille (1978). According to Rowe and Gates (1995) the type locality is Foa Island, Tonga.

Ophiarachna affinis **Lütken, 1869**
(Plate 2.8C, D)

Ophiarachna affinis Lütken, 1869: 34, 98; De Loriol, 1893b: 411-413; Clark, 1909: 128; Koehler, 1904b: 76-77; Clark, 1915a: 299, pl. 18, figs 1, 2; Koehler, 1922b: 333-335, pl. 4, fig. 1; Koehler, 1930: 271-272, pl. 14, fig. 1; Clark and Rowe, 1971: 88-89, 123, fig. 42a; Devaney, 1974: 175-176; Sloan *et al.*, 1979: 111, figs 17, 18; Rowe and Gates, 1995: 395.
Ophiarachna clavigera Brock, 1888: 495-497.

Material / Records
RMCA MT2344, -27.5367°, 32.6900°, Sodwana Bay, depth 31m, 6 June 2003, SCUBA, collected by Y. Samyn, determined by Y. Samyn and M. Garcia. RMCA MT2140, -27.5227°, 32.6919°, Sodwana Bay, depth 15m, 10 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. SAMC A28121, SAMC A28132, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 23 July 1976, dredge, J.L.B. Smith Institute, determined by J.M. Olbers.

Diagnosis *(See Clark, 1915a; Devaney, 1974)*
D.D. up to 28mm. Disc round, somewhat puffy, densely covered in round granules both dorsally and ventrally, granules extending onto oral plates. Radial shields not distinct. Oral shields naked, spearhead-shaped with marbled patterns, single supplementary plate, naked, half width of oral shield. Adoral shields small, not contiguous. Oral papillae five to six, shape varies, broad, elliptical leaf-shaped, middle papillae more slender than proximal and distal ones. Oral tentacle scales three, deep in mouth. Teeth five, lowest tooth square becoming pointed. Genital slits long and reach edge of disc margin, genital papillae absent, but disc granules up to edge of slit. Arm spines up to five, lowermost spine flattened and blunt, others flattened, but conical or tapering, twice segment length, basally lowermost arm spines may reach three to four times segment length. Dorsal arm plates rectangular, with slight distal concave notch on distal side, twice as wide as long proximally, becoming equal distally. Ventral arm plates square to fan-shaped proximally, becoming longer than wide distally, distal edges slightly convex, plates have thin lighter margin along whole arm length. Tentacle scales two, oval, outer one somewhat rectangular. Colour in life, disc brown and grey with widely spaced spots both dorsally and ventrally, arms banded with broad dark and light brown bands of four to nine segments, with four longitudinal dark lines down the length of arm. Arm spines annulated with grey and brown.

Global distribution
Indonesia, Aldabra, Australia, Fiji, Samoa, Mozambique, Seychelles, Red Sea, East Indies, Philippines and South Pacific Islands (Clark, 1909; Clark and Rowe, 1971; Rowe and Gates, 1995; Richmond, 2002), South Africa.

Ecology
Depth range: 0-31m.
Habitat: Found under *Porites* colonies over sandy gravel, under boulders over sand and rubble and among coral rubble (Devaney, 1974; Sloan *et al.*, 1979).

Remarks
Apart from the different oral configuration, this species is similar in colouration to *Ophiocoma* (*Breviturma*) *doederleini,* but distinguished by the presence of four longitudinal dark lines along arms.

According to Rowe and Gates (1995) the type locality is Fiji Islands, with the holotype held at the Natural History Museum of Denmark (ZMUC OPH-470) (Tom Schiøtte, pers. comm.)

Ophiarachnella gorgonia (Müller and Troschel, 1842)
(Plate 2.8E, F)

Ophiarachna gorgonia Müller and Troschel, 1842:105.
Pectinura gorgonia: Lütken, 1869: 15; Lyman, 1882: 15; Koehler, 1898b: 58, pl. 2, figs 1, 2.
Pectinura marmorata Lyman, 1874: 222, pl. 5, figs 1-7.
Pectinura venusta De Loriol, 1893a: 16-19, pl. 23, fig. 3.
Ophiarachnella marmorata: Clark, 1915a: 305.
Ophiarachnella gorgonia: Clark, 1909: 123-124; Matsumoto, 1917: 323-324, pl. 6, fig. 7; Clark, 1921: 141-142, pl. 12, fig. 5, pl. 35, figs 4, 5; Koehler, 1922b: 339-340; Clark, 1946: 260-261; Clark, 1965: 66; Clark and Rowe, 1971: 88, 125, fig. 42b, pl. 20, fig. 2; Cherbonnier and Guille, 1978: 217-218, pl. 15, figs 5, 6; Sloan *et al.*, 1979: 111; Tortonese, 1980: 129; Humpreys, 1981: 10; Irimura, 1982: 66, 67, fig. 39, pl. 13, fig. 6; Guille and Vadon, 1985: 64; Marsh *et al.*, 1993: 62; Rowe and Gates, 1995: 396; Putchakarn and Sonchaeng, 2004: 423.

Material / Records

RMCA MT2139, -27.5227°, 32.6919°, Sodwana Bay, depth 8-24m, 10 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2256, RMCA MT2266, -30.2637°, 30.8264°, Aliwal Shoal, depth 14-18m, 3 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2329, Sodwana Bay, depth unknown, 21 July 2000, SCUBA, collected by Y. Samyn and I. Tallon, determined by M. Garcia. RMCA MT2322, RMCA MT2327, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth unknown, 12-24 July 2000, SCUBA, collected by Y. Samyn and I. Tallon, determined by M. Garcia. RMCA MT2144, -26.9335°, 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2328, -27.4472°, 32.7167°, Sodwana Bay, 7-mile Reef, depth unknown, 22 July 2000, SCUBA, collected by Y. Samyn and I. Tallon, determined by M. Garcia.

Diagnosis *(See Cherbonnier and Guille, 1978)*

D.D. up to 19mm. Disc rounded with slight indentations on both sides at base of arms, covered in rounded granules dorsal and ventrally, peripheral granules slightly elongated. Radial shields naked, ovate, longer than wide, relatively small. Granules on ventral interradial areas closely packed up to oral shields and onto oral plates or jaws. Oral shields naked, pentagonal, large, supplementary oral shields distal to each oral shield, D-shaped, often equal to length of oral shield. Adoral shields small, not contiguous, triangular. Oral papillae oval and flattened, distalmost broadest. Teeth four to five, lowermost square, others pointed. Genital slits reach disc margin, genital papillae absent, but disc granulation to slit edge. Arms triangular in cross-section for more than half arm length. Arm spines up to 11, appressed to arm, tapering, approximately half segment length. Dorsal arm plates elliptical proximally, twice as wide as long, broadly in contact, becoming fan-shaped and narrowly in contact in distal parts. Distal edge on proximal-most segments sometimes scalloped. Ventral arm plates hexagonal, distal edge convex, becoming flattened distally, wider than long proximally, but longer than wide distally. Tentacle scales two for most of the arm length, inner one oval and long, outer one rectangular and slightly pointed. Colour in life, disc green, brown and white with patches both dorsally and ventrally, radial shields may be mottled white, arms banded dark green and white, ventrally uniformly white, with white patches on interradial areas. Arm spines similar in colouration to arm segments.

Global distribution

China, Japan, Australia, East Indies, Philippines, South Pacific Islands, Ceylon, Bay of Bengal, Thailand, Somalia, Tanzania, Kenya, Madagascar, Mozambique, Mascarene Islands, islands of the Western Indian Ocean, Red Sea, Mauritius (Clark and Rowe, 1971; Rowe and Gates, 1995), South Africa.

Ecology

Depth range: 0-39m.

Habitat: Under *Porites* colonies over gravel, beneath encrusting coral colonies, rubble and among algae (Sloan *et al.*, 1979; Humpreys, 1981).

Remarks

Some disc scales exposed, but may be a result of granules being rubbed off. All South African records held at the Royal Museum for Central Africa.

Hoareau *et al.* (2013) found three clades within *O. gorgonia*, two from the Western Indian Ocean. Based on the colour morphology, it is believed that this species is from Hoareau's lineage number two. However, sequencing the South African *O. gorgonia* specimens would be required to confirm this.

Ophiarachnella septemspinosa (Müller and Troschel, 1842)

(Plate 2.9A, B)

Ophiarachna septemspinosa Müller and Troschel, 1842: 105-106.
Pectinura septemspinosa Lütken, 1869: 15; Lyman, 1882: 17; De Loriol, 1893b: 395, pl. 13, fig. 2; Koehler, 1905a: 9.
Pectinura rigida Lyman, 1874: 224.
Ophiarachna armata Troschel, 1879: 137-138.
Ophiarachnella septemspinosa: Clark, 1909: 126; Koehler, 1930: 273; Clark, 1938: 349-350; Clark, 1946: 263-264; Cherbonnier and Guille, 1978: 218-219, pl. 16, figs 1, 2; Humpreys, 1981: 10; Guille and Vadon, 1985: 64; Marsh *et al.*, 1993: 62; Rowe and Gates, 1995: 397; Mbongwa, 2013: 16.

Material / Records

RMCA MT2137, RMCA MT2143, RMCA MT2138, RMCA MT2334, -27.5367°, 32.6900°, Sodwana Bay, depth 8-30m, 10-15 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia and Y. Samyn. RMCA MT2295, RMCA MT2245, RMCA MT2244, -30.2637°, 30.8264°, Aliwal Shoal, depth 15-44m, 5-13 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia and Y. Samyn. RMCA MT2141, -26.9335°, 32.8871°, Bhanga Nek, depth 16m, 15 August 1999, SCUBA, collected by Y. Samyn and E. Vanden Berghe, determined by M. Garcia. RMCA MT2350, -27.5367°, 32.6900°, Sodwana Bay, depth 31m, 7 November 2003, SCUBA, collected by Y. Samyn, determined by Y. Samyn and J.M. Olbers. RMCA MT2348, -30.8332°, 30.4343°, Protea Banks, depth 38m, 13 November 2003, SCUBA, collected by Y. Samyn, determined by Y. Samyn and J.M. Olbers. EKZNW LSS_4_EKZNW, -27.8667°, 32.6000°, Leadsman Shoal, depth 11m, 13 October 2010, SCUBA, collected by J. Wood and J. Dives, determined by J.M. Olbers. EKZNW AS_1_JMO_2008, -30.2669°, 30.8001°, Aliwal Shoal, depth 17m, 14 June 2008, SCUBA, collected by J. Wood and J. Dives, determined by J.M. Olbers.

Diagnosis *(See Cherbonnier and Guille, 1978)*

D.D. up to 38mm. Disc round, flat, densely covered in granules both dorsally and ventrally, extending onto jaws. Radial shields naked, contrasting in colour with disc, small, circular. Oral papillae three to four, elliptical, slightly pointed. Teeth broad, but not square. Oral shields naked, oval, but truncated distally by large supplementary oral shield, as wide as oral shield, some specimens have marbled oral shields. Adoral shields small, not contiguous. Genital slits long and reaching edge of disc margin, genital plate distinct and slightly higher than interradial area. Dorsal arm plates elliptical rectangular, more than twice as long as wide, rounded lateral angles, proximal edges straight, distal margins may be scalloped. Ventral arm plates hexagonal, convex distally, somewhat concave proximally, wider than long, becoming longer toward distal end of arm, tentacle pore indenting lateral edges. Arm spines up to nine, conical or tapering, same length as segment with exception of lowermost arm spine, which is twice as long as segment, cigar-shaped, flattened and tip square. Tentacle scales two, oval, outer one somewhat broader than inner, becoming one distally. Colour in life uniformly grey, red, yellow or greenish, ventrally lighter, radial shields similar in colour but lighter than disc, arms banded.

Global distribution

Aldabra, Mascarene Basin, Western Indian Ocean, Kenya, Madagascar, Mozambique, Red Sea, Mauritius, Seychelles, Tanzania, China and South Japan, Australia, East Indies, Philippine Islands, Maldives (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Rowe and Gates, 1995; Richmond, 2002), South Africa (Mbongwa, 2013).

Ecology
Depth range: 0-55m.
Habitat: Found under boulders over sand, under coral (*Millepora* spp.) colonies, in sand channels and rubble areas of reef flats (Sloan *et al.*, 1979; Humpreys, 1981).

Remarks
Easily recognisable by the small radial shields and striking colours. The South African specimens are 'very red' in comparison to the Australian red specimens and may represent a cryptic species complex (Tim O'Hara, pers. comm.).

According to Rowe and Gates (1995) the type locality is the Moluccas, Indonesia. Type material is housed in the Naturalis (ZMA.ECH.O 7084 and RMNH.ECH. 3566; Joke Bleeker, pers. comm.).

Family OPHIOLEPIDIDAE Ljungman, 1867

***Ophioplocus imbricatus* (Müller and Troschel, 1842)**
(Plate 2.9C, D)

Ophiolepis imbricata Müller and Troschel, 1842: 93-94.
Ophioplocus tessellatus Lyman, 1862: 76-77.
Ophioplocus imbricatus: Lyman, 1865: 69-70; Lyman, 1882: 20, pl. 35, figs 10-12; Studer, 1882: 7; De Loriol, 1893a: 12-13; Bell, 1898: 849; Bell, 1909: 11; Koehler, 1922b: 435-436; Koehler, 1922a: 48, pl. 84, fig. 12; Clark, 1915a: 344; Clark, 1921: 143, pl. 12, fig. 8, pl. 35, figs 1-3; Clark, 1938: 365-366; Clark, 1946: 275-276; Clark and Rowe, 1971: 90-91, 128; Cherbonnier and Guille, 1978: 239-242, fig. 77a-f; Humpreys, 1981: 11; Guille and Vadon, 1985: 64; Rowe, 1989: 287; Putchakarn and Sonchaeng, 2004: 423; Stöhr *et al.*, 2008: 547, 553.
Ophioplocus imbricata: Rowe and Gates, 1995: 435.

Material / Records
RMCA MT2306, -27.6180°, 32.6880°, Sodwana Bay, depth 10m, July 2000, SCUBA, collected by Y. Samyn and I. Tallon.

Diagnosis *(See Clark and Rowe, 1971; Cherbonnier and Guille, 1978)*
D.D. up to 11mm. Disc round, disc scales slightly imbricated and distinct, with central plate present, scales naked. Radial shields small, elongated oval, widely separated, naked. Genital slits small, short, quarter length of interradial area, genital papillae present. Oral shields triangular, moderately large, much wider than long, rounded angles, widest distally. Adoral shields relatively wide, may be contiguous or slightly separated. Jaws slightly sunken, four to five oral papillae, distalmost being broadest, remaining papillae elliptical leaf-shaped, apical papillae bluntly pointed. Teeth four, rounded. Oral tentacle scale inside oral slit. No arm combs. Dorsal arm plates fragmented along entire length of arm, with lateral arm plates becoming more prominent distally. Ventral arm plates slightly wider than long, rectangular and contiguous, becoming triangular and non-contiguous distally, distal edge rounded throughout. Arm spines three, stout, thick, conical, mostly appressed to arms, no longer than one segment length, becoming shorter distally, occasionally lowermost longest. Tentacle scales two, ovate or similar to spines in shape, rarely three. Colour in life dark green or grey with irregular patterns and patches on dorsal disc conforming to interradial areas, arms banded, ventrally brown but pale.

Global distribution
Somalia, Aldabra, Mascarene Basin, Kenya, Madagascar, Mozambique, New Zealand, Red Sea, Mauritius, Seychelles, Tanzania, Australia, Reunion, Andaman Sea (Rowe and Gates, 1995; Putchakarn and Sonchaeng, 2004; Stöhr *et al.*, 2008; Stöhr, 2007f), South Africa.

Ecology
Depth range: 0-197m (Koehler, 1922b).
Habitat: Found with grey sand and mud (Koehler, 1922b), angiosperm beds, bases of coral or patch reefs (Humpreys, 1981).

Remarks
Both Müller and Troschel (1842) and Rowe and Gates (1995) reported the type localities as Mauritius and Timor (Indonesia) which is surprising, as these locations are extremely far apart. A broken non-type specimen was located at the Naturalis which was recorded from Indonesia (Joke Bleeker, pers. comm.). Clark (1938) reported examining a number of specimens with colours ranging from grey to those with the dorsal disc tinted with orange and orange or red-orange ventrally, particularly near the oral shields, while others were light brown dorsally and orange-red ventrally.

DISCUSSION

Although no species new to science were found during this study, 24 species new to South Africa are documented. This represents more than an 18% addition to the ophiuroid fauna of the region, representing a significant addition to the fauna.

The large number of records from the east coast suggests under-sampling, compared to the south and west coasts, which have historically been more thoroughly sampled (Griffiths *et al.*, 2010). Deep-water sampling is also required, especially on the east coast, and abyssal sampling is virtually non-existent in the whole region (Griffiths *et al.*, 2010). Of the 145 new data records, 137 were from KwaZulu-Natal, four from the Western Cape, four from the Eastern Cape and no records from the Northern Cape.

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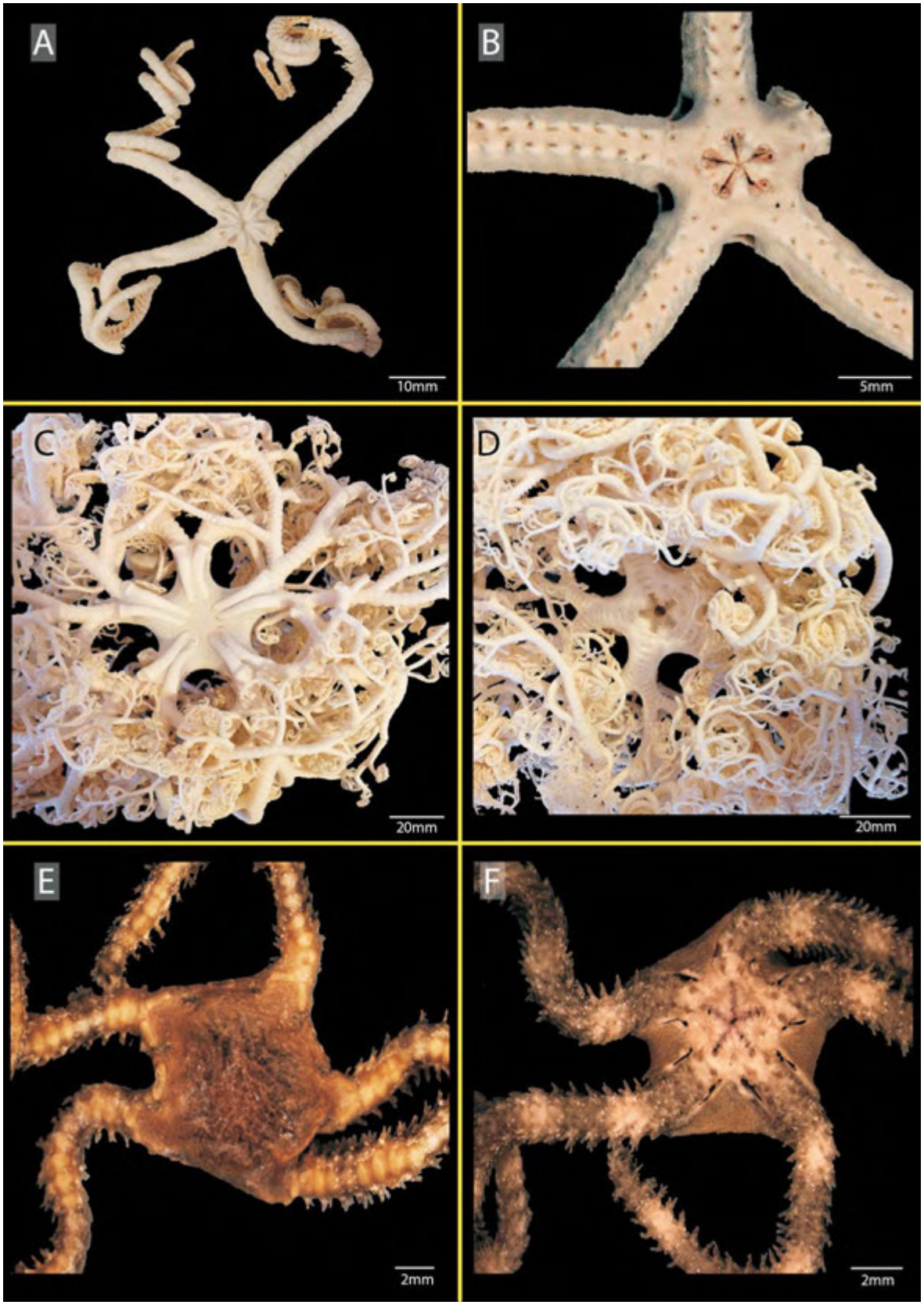

Plate 2.1. Dorsal (**A**) and ventral (**B**) views of *Asteroschema salix*, SAMC A28143, -31.0000°, 30.4500°, off Glenmore, depth 900m, 12 May 1977, *Meiring Naude*, station number SM134, beam trawl. Photograph provided by D. Van den Spiegel. Dorsal (**C**) and ventral (**D**) views of *Astroglymma* cf. *sculptum*, SAMC A74047, -27.7668°, 32.6500°, NE Gypsea Hill, depth 84-90m, 9 June 1990, *Meiring Naude*, station number ZK22, Natal Museum Dredging Programme. Dorsal (**E**) and ventral (**F**) views of *Ophiomyxa australis*, RMCA MT2274, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 13m, 9 August 1999. Photograph provided by D. Van den Spiegel.

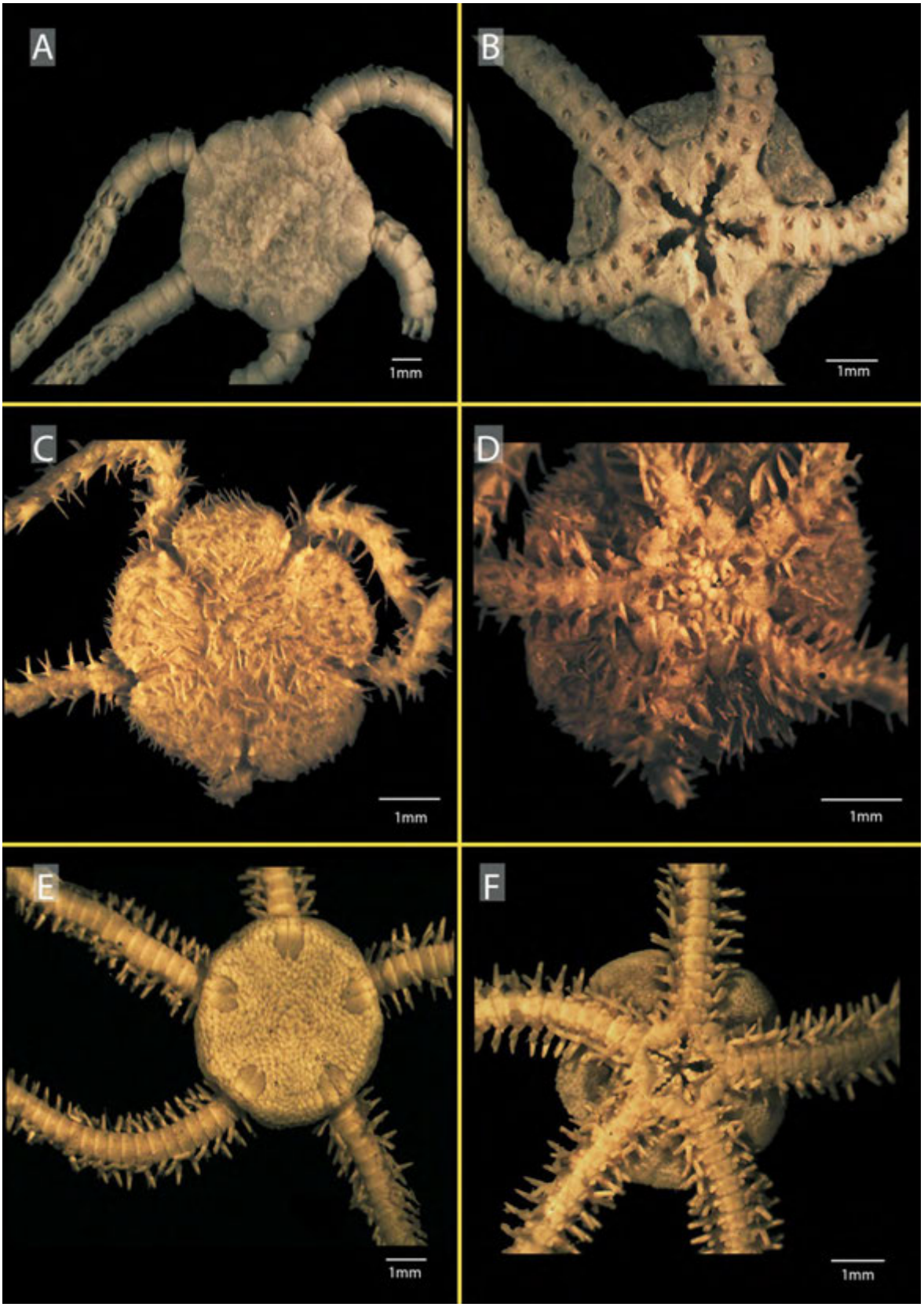

Plate 2.2. Dorsal (**A**) and ventral (**B**) views of *Ophiernus quadrispinus*, SAMC A22018, off Saldanha Bay, -33.8116°, 16.5000°, depth 2730m, 27 August 1959, trawl, *Africana II*, station number A193. Dorsal (**C**) and ventral (**D**) views of *Amphilimna cribriformis*, SAMC A22787 (paratype), NE of Durban, depth 86m, -29.4833°, 31.7500°, dredge, mud, 9 September 1964, station number NAD52E. Dorsal (**E**) view and ventral (**F**) views of *Amphioplus* (*Lymanella*) *depressus*, SAMC A74078, -34.0817°, 23.0126°, Knysna, depth 0m, 7 July 1960, collected by hand, UCT Ecological Survey Collection.

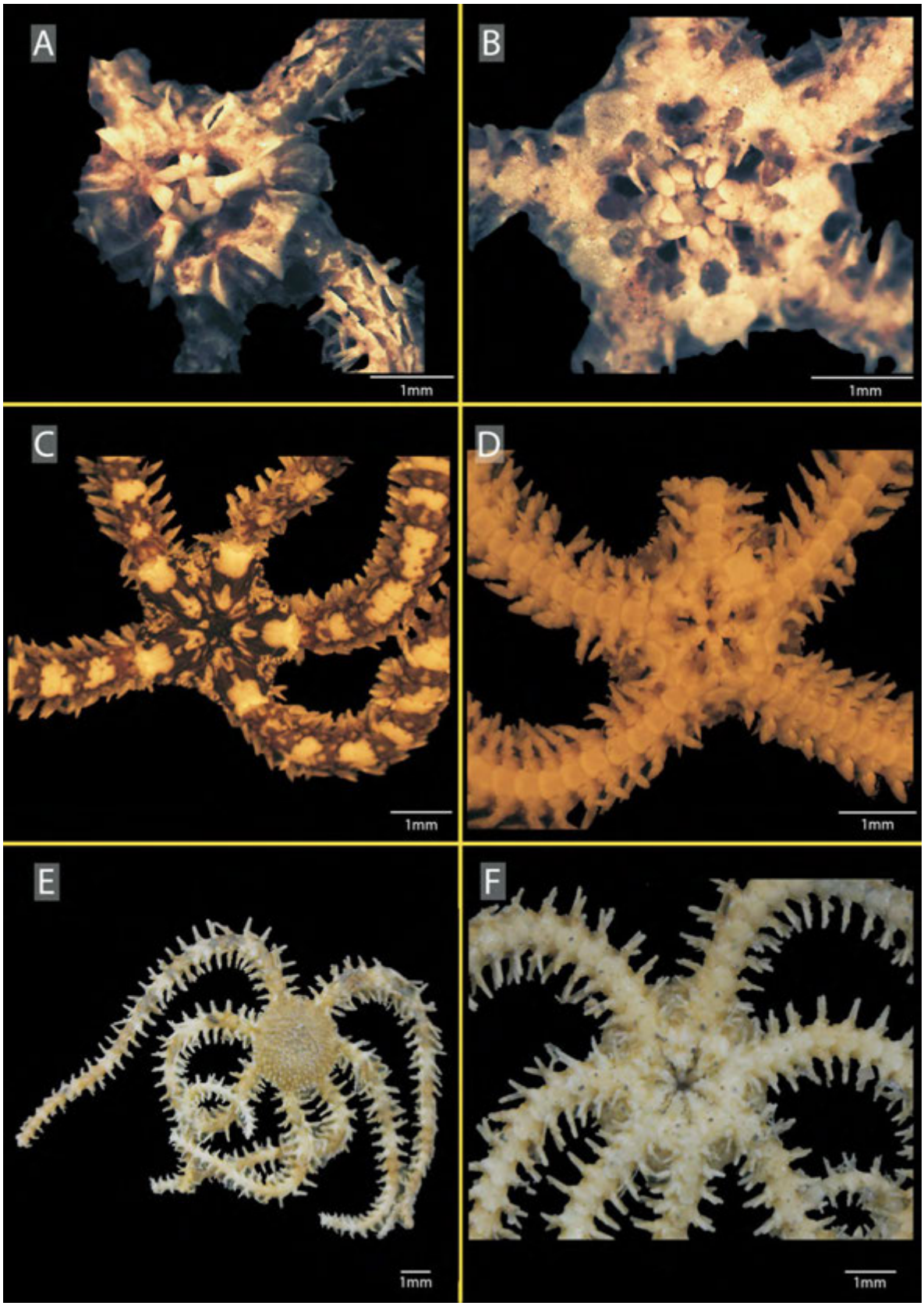

Plate 2.3. Dorsal (**A**) and ventral (**B**) views of *Ophionephthys lowelli*, SAMC A22781, NE of East London, depth 55m, -32.5505°; 28.6352°, dredge, sand and mud, 16 July 1959, station number SCD74S. Dorsal (**C**) and ventral (**D**) views of *Ophiactis* cf. *picteti* SAMC A74065, -27.5230°; 32.6920°, Sodwana Bay, depth 12.5m, 15 October 2010, SCUBA. Dorsal (**E**) and ventral (**F**) views of *Ophiocomella sexradia*, EKZNW RR_4_JMO_2010, -29.9861°; 30.9645°, Reunion Rocks, intertidal, 24 September 2010.

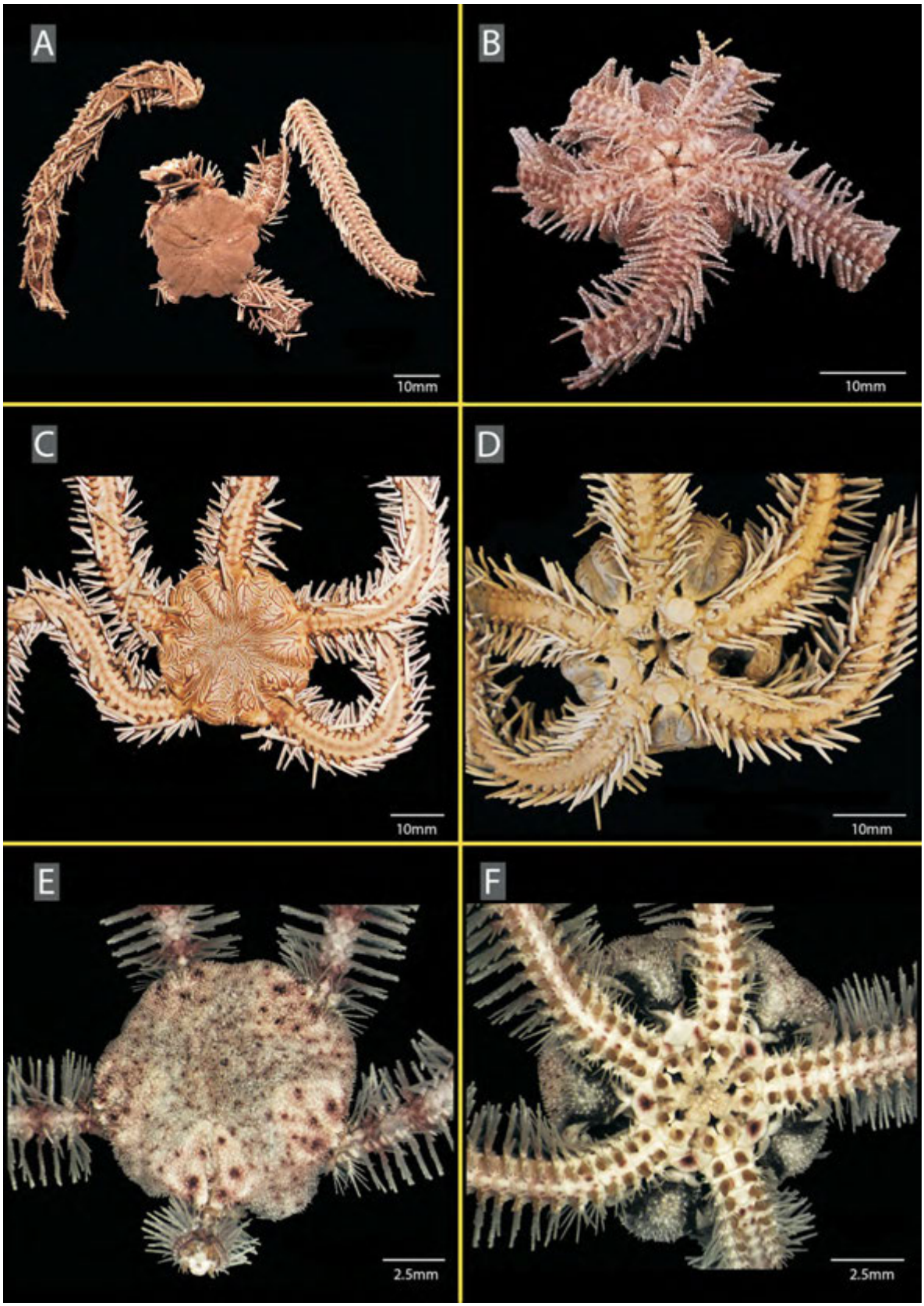

Plate 2.4. Dorsal (**A**) and ventral (**B**) views of *Ophiomastix koehleri*, SAMC A28130, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, 25 July 1976, SCUBA, J.L.B. Smith Institute. Dorsal (**C**) and ventral (**D**) views of *Ophiomastix venosa*, RMCA MT2353, -27.5227°, 32.7129°, Sodwana Bay, depth 21m, 7 November 2003. Dorsal (**E**) and ventral (**F**) views of *Macrophiothrix demessa*, RMCA MT2156, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 13m, 4 September 1999.

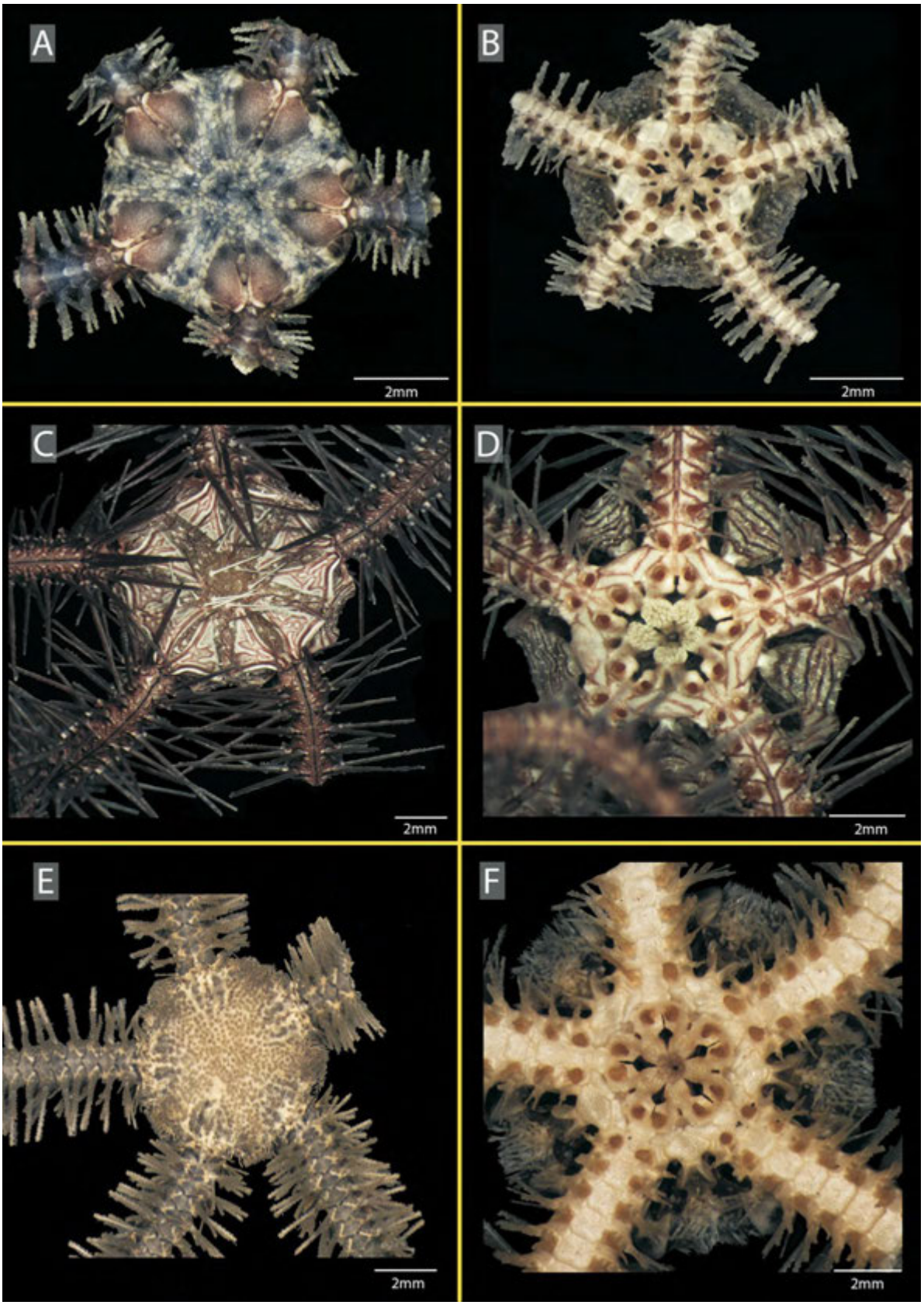

Plate 2.5. Dorsal (**A**) and ventral (**B**) views of *Macrophiothrix propinqua*, RMCA MT2216, -27.5227°, 32.6919°, Sodwana Bay, depth unknown, 10 April 1999. Dorsal (**C**) and ventral (**D**) views of *Ophiothrix* (*Acanthophiothrix*) *purpurea*, RMCA MT2185, -27.5227°, 32.6919°, Sodwana Bay, depth 12m, 8 April 1999, SCUBA. Dorsal (**E**) and ventral (**F**) view of *Ophiothrix* (*Ophiothrix*) *echinotecta*, RMCA MT2257, -27.9335°, 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, SCUBA.

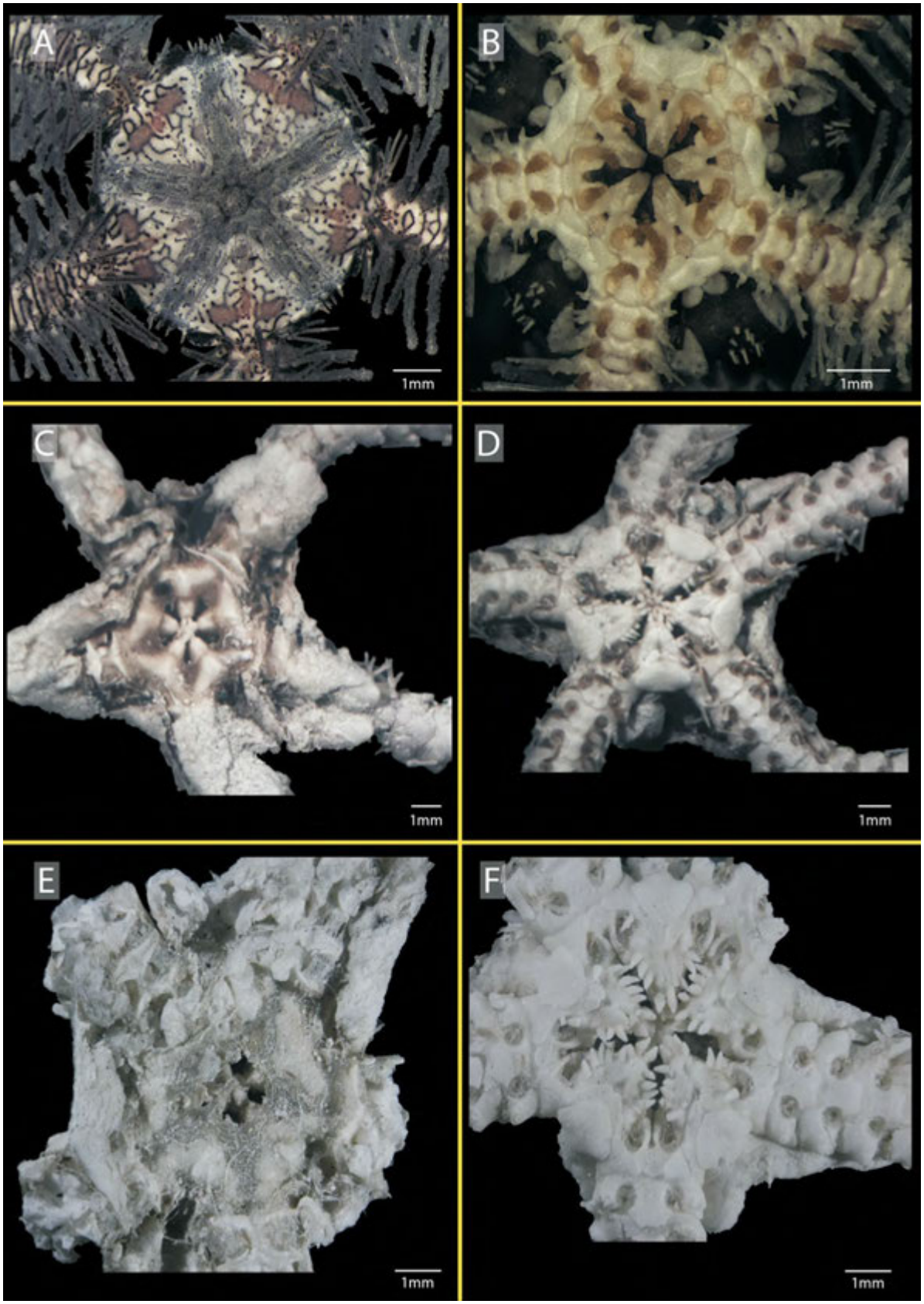

Plate 2.6. Dorsal (**A**) and ventral (**B**) views of *Ophiothrix* (*Ophiothrix*) *foveolata*, RMCA MT2174, -27.4132°; 32.7268°, Sodwana Bay, 9-mile Reef, depth 18m, 12 August 1999, SCUBA. Dorsal (**C**) and ventral (**D**) views of *Ophiotoma* cf. *alberti* SAMC A22112, -33.8116°; 16.5000°, off Saldanha Bay, depth 2730m, 27 August 1959, trawl, *Africana II*, station number A193. Dorsal (**E**) and ventral (**F**) views of *Ophiotoma* cf. *gracilis*, SAMC A22103, -34.6166°; 17.0500°, off Cape Town, depth 2875-2948m, 8 December 1959, trawl, *Africana II*, station number A315.

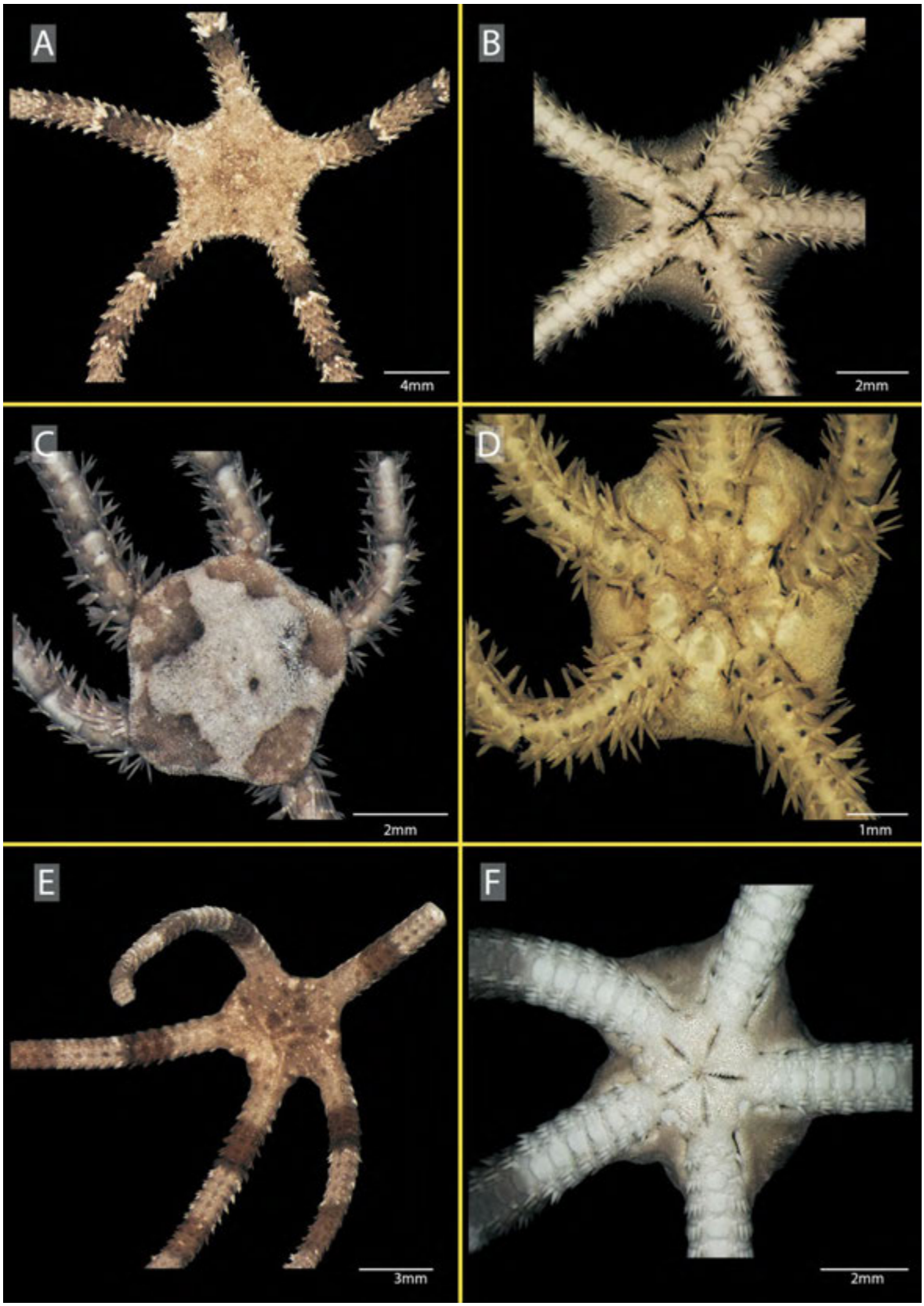

Plate 2.7. Dorsal (**A**) and ventral (**B**) view of *Ophiochaeta hirsuta*, RMCA MT2290, RMCA MT2291, -27.5227°, 32.6919°, Sodwana Bay, depth 8-24m, 8-10 August 1999, SCUBA. Dorsal (**C**) and ventral (**D**) views of *Ophioconis cupida*, SAMC A74041, -26.8669°, 32.9167°, NE of Kosi Bay, depth 49m, 3 June 1990, dredge, *Meiring Naude*, station number ZA41, Natal Museum Dredging Programme. Dorsal (**E**) and ventral (**F**) views of *Ophiodyscrita acosmeta*, RMCA MT2183, -27.4472°, 32.7167°, Sodwana Bay, 7-mile Reef, depth 23m, July 2000, SCUBA.

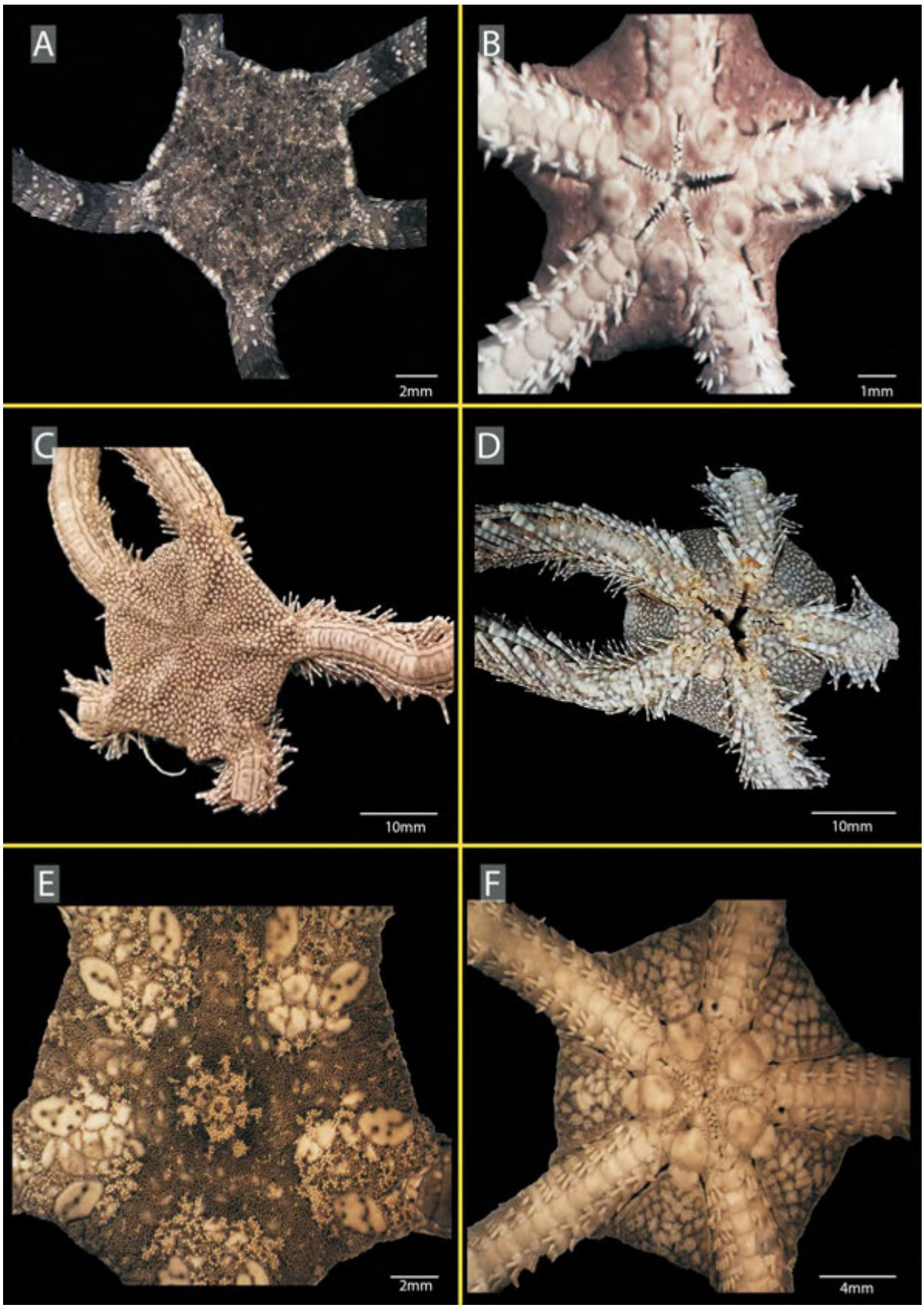

Plate 28. Dorsal (**A**) and ventral (**B**) views of *Ophiopeza spinosa*, RMCA MT2284, RMCA MT2296, -26.9335°; 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, SCUBA. Dorsal (**C**) and ventral (**D**) views of *Ophiarachna affinis*, SAMC A28132, -27.5166°; 32.6833°, Sodwana Bay, depth 15m, 23 July 1976, dredge, J.L.B. Smith Institute. Dorsal (**E**) and ventral (**F**) views of *Ophiarachnella gorgonia*, RMCA MT2144, -26.9335°; 32.8871°, Bhanga Nek, depth 20m, 14 August 1999, SCUBA. Photograph provided by D. Van den Spiegel.

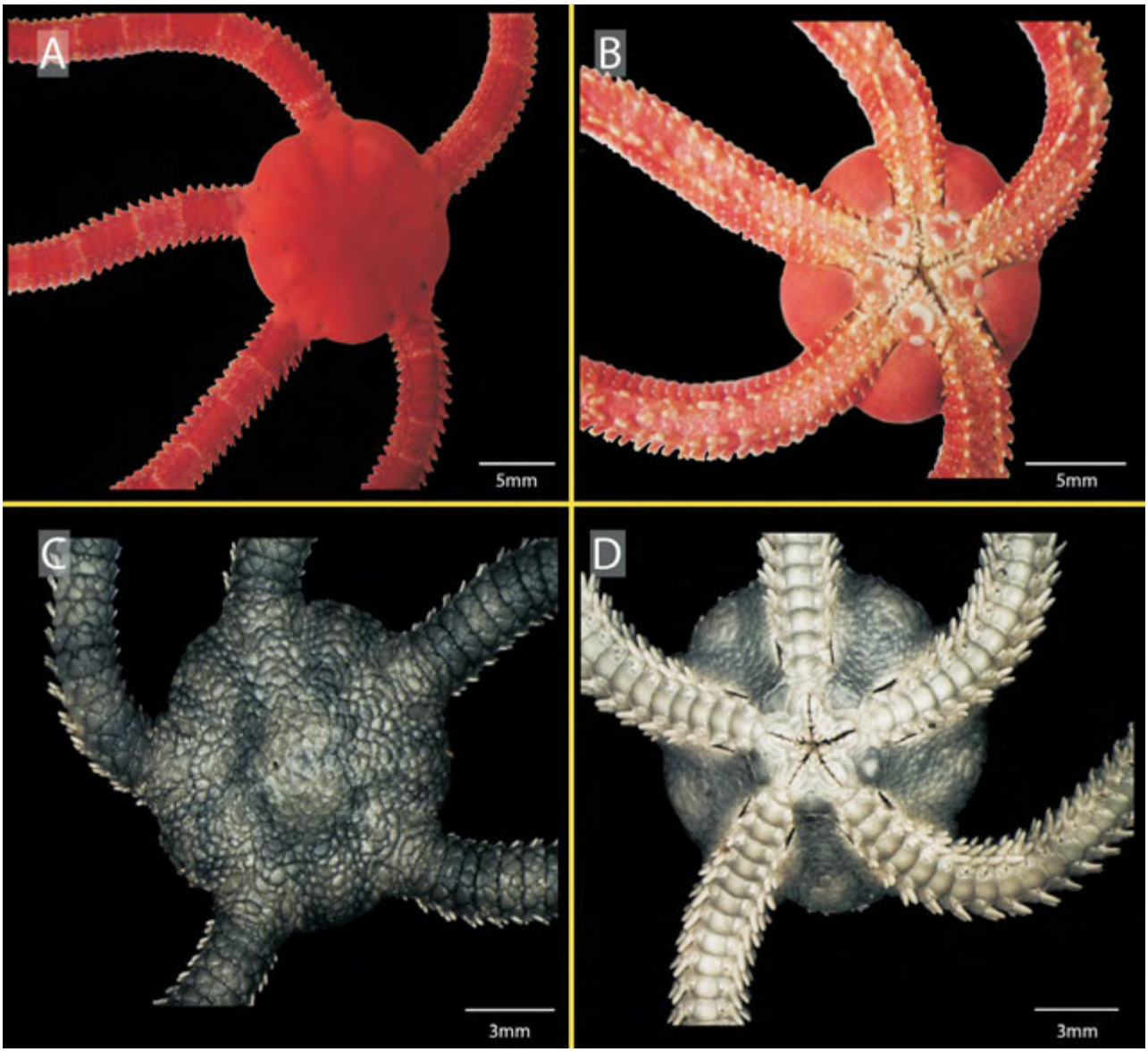

Plate 2.9. Dorsal (**A**) and ventral (**B**) views of *Ophiarachnella septemspinosa*, EKZNW LSS_4_EKZNW, -27.8667°, 32.6000°, Leadsman Shoal, depth 11m, 13 October 2010, SCUBA. Dorsal (**C**) and ventral (**D**) views of *Ophioplocus imbricatus*, RMCA MT2306, -27.6180°, 32.6880°, Sodwana Bay, depth 10m, July 2000, SCUBA, photograph provided by D. Van den Spiegel.

Chapter 3: The *Ophiocoma* species (Ophiurida: Ophiocomidae) of South Africa[1].

ABSTRACT

This study raises the number of *Ophiocoma* species recorded in South Africa from four to eight. All species are briefly discussed in terms of taxonomy, geographic distribution and ecology. In addition, the juvenile of *O. brevipes*, found on the underside of adult *O. brevipes* specimens, is described in detail. A neotype is designated for *O. scolopendrina*.

INTRODUCTION

The circumtropical family Ophiocomidae holds some of the more dominant and conspicuous ophiuroid species present on coral and rocky reefs. The family is rich, with eight genera, two of which were relatively recently reviewed by Devaney (1968; 1970; 1978). One of these, *Ophiocoma* Agassiz, 1836, is well represented in the tropical to subtropical waters of KwaZulu-Natal in South Africa and its constituent species are documented here.

Ophiocoma species are difficult to identify, since some of the distinctive taxonomic characters, such as the shape of the oral and dental plates and their associated papillae (see Devaney, 1970), are not easily assessed, or can change during growth, as is also the case for the number of arm spines, the disc armament and the size of the dorsal arm plates (Sumida *et al.*, 1998; Stöhr, 2005; Stöhr *et al.*, 2008). In addition, some species can change their colouration from day to night (Hendler, 1984).

The Indo-Pacific distribution of *Ophiocoma* has been dealt with by several authors (e.g. Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Rowe and Gates, 1995). Clark and Rowe (1971) listed 11 species from the Indo-West Pacific (including the Red Sea and the Persian Gulf). Since then, a few new species have been added (Rowe and Pawson, 1977; Bussarawit and Rowe, 1985; Soliman, 1991; Benavides-Serrato and O'Hara, 2008), bringing the total number of valid species in the Indo-Pacific to 13[2]. The ophiuroid fauna of southern Africa has been studied by many specialists (Bell, 1905; Bell, 1909; Clark, 1923; Mortensen, 1925; Mortensen, 1933c; Balinsky, 1957; Balinsky, 1969; Clark, 1974; 1977; 1980; Clark and Courtman-Stock, 1976) but, since Clark and Courtman-Stock's (1976) work, no *Ophiocoma* species have been added to the fauna of southern Africa. Samyn and Thandar (2003), however, mention that *de novo* sampling along the coast of KwaZulu-Natal revealed many new ophiuroid records. Unfortunately, the latter authors did not include their species list.

Until now, only four species of *Ophiocoma* have been recorded in South Africa (Clark and Courtman-Stock, 1976): *O. erinaceus* Müller and Troschel, 1842, *O. pica* Müller and Troschel, 1842, *O. scolopendrina* (Lamarck, 1816) and *O. val*enciae Müller and Troschel, 1842. Recent sampling along the north-east coast of South Africa (see also Samyn and Thandar, 2003), yielded four additional *Ophiocoma* species. Moreover, an undiscovered and undocumented association between individuals believed to be an adult and juvenile *O. brevipes* is discussed below.

[1] Since the publication of this chapter in the *Western Indian Ocean Journal of Marine Science*, a number of changes to the nomenclature have taken place. The names, as published in 2012, have been retained but noted here. See Stöhr *et al.* (2013) for updated nomenclature.
[2] *Ophiocoma anaglyptica* Ely; *O. aegyptiaca* Soliman, 1991, *O. brevipes* Peters, *O. cynthiae* Bennavides-Serrato & O'Hara, *O. dentata* Müller & Troschel, *O. endeani* Rowe & Pawson, *O. erinaceus* Muller & Troschel, *O. occidentalis* Clark, *O. pica* Müller & Troschel, *O. pusilla* (Brock), *O. schoenleinii* Müller & Troschel, *O. scolopendrina* (Lamarck), *O. valenciae* Müller & Troschel.

MATERIALS AND METHODS

Specimens were collected by hand in the intertidal zone and by SCUBA diving up to 32m depth, during six expeditions (August 1999, July 2000, February 2001, July 2003, January 2010 and October 2010) at several localities along the coast of KZN, South Africa (Figure 3.1).

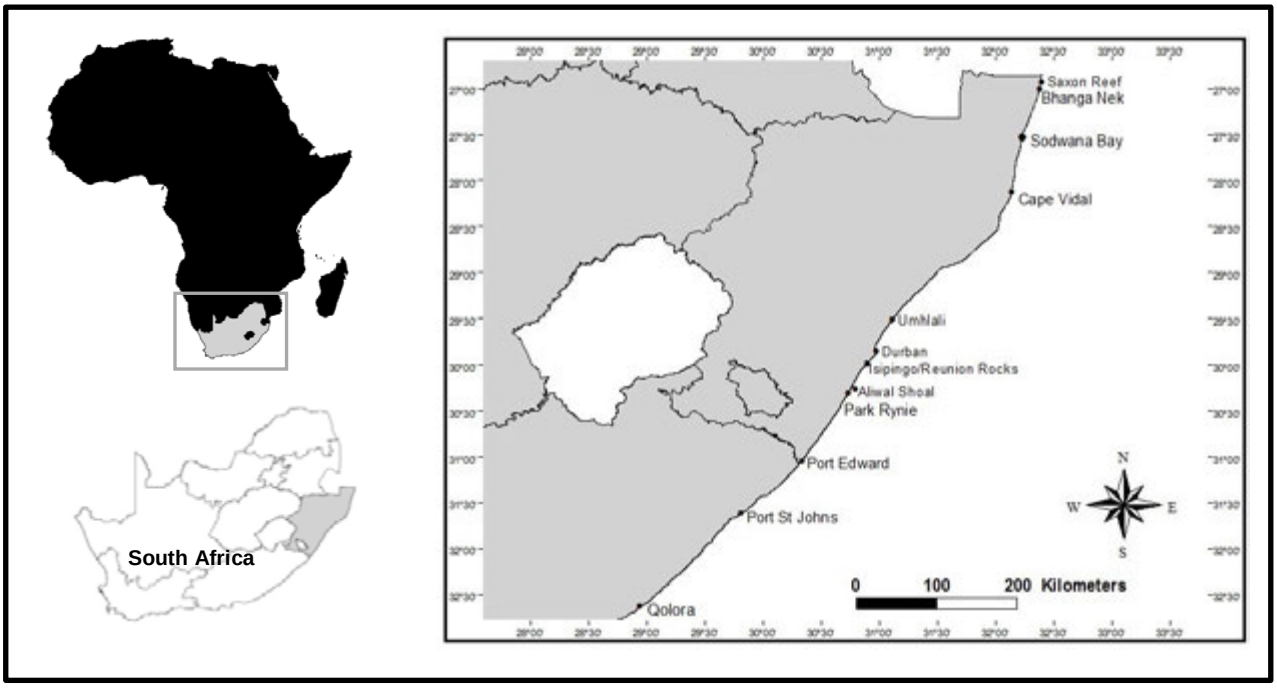

Figure 3.1. Sites where *Ophiocoma* species have been recorded in South Africa.

Specimens were anaesthetised by placing them in freshwater and gently manipulating them so that their arms were extended as far as possible until they ceased moving. Thereafter, they were put in 100% buffered ethyl alcohol for one day and transferred to 70% buffered ethyl alcohol for transport to the laboratory, where they were dried for permanent storage. The specimens were photographed after preservation.

Specimens are deposited in the collections of the RMCA (Belgium) and in the SAMC (South Africa). These collections were examined together with other vouchers in the RMCA (e.g. from Kenya, the Seychelles and Inhaca; see also Clark, 1980), as well as some ophiocomids from the Indo-Pacific Ocean in the MNHN (France).

RESULTS

Details of the collection of different *Ophiocoma* species sampled along the KZN coast of South Africa are presented in Table 3.1.

Table 3.1. Records of the present South African collection of *Ophiocoma* species, showing location, depth, museum collection numbers and the number of specimens.

Valid species name	Location	Depth (m)	Collection number (no. of specimens)
Ophiocoma brevipes	Aliwal Shoal	20	RMCA MT 2199 (1)
	Sodwana Bay	14	RMCA MT 2207 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2175 (1)
	Sodwana Bay (Mabibi)	15	RMCA MT 2215 (1)
	Sodwana Bay (2-mile Reef)	11	RMCA MT 2191 (1)
	Sodwana Bay (2-mile Reef)	11	RMCA MT 2157 (1)
	Sodwana Bay (9-mile reef)	6	RMCA MT 2192 (1)
	Sodwana Bay (9-mile reef)	6	RMCA MT 2225 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2222 (1)
	Sodwana Bay (Mabibi)	16	RMCA MT 2194 (1)
	Aliwal Shoal	13	RMCA MT 2195 (1)
	Sodwana Bay (Diep Gat)	10	RMCA MT 2198 (2)
	Sodwana Bay (2-mile Reef)	11	RMCA MT 2179 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2212 (1)
	Sodwana Bay (2-mile Reef)	14	RMCA MT 2193 (1)
	Aliwal Shoal	13	RMCA MT 2148 (3)
	Sodwana Bay	?	RMCA MT 2208 (2)
	Bhanga Nek	16	RMCA MT 2203BIS (2)
	Aliwal Shoal	20	RMCA MT 2199 (1)
	Sodwana Bay (2-mile Reef)	14	SAMC A 28111 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2341 (2, juv.)
	Sodwana Bay (2-mile Reef)	14	SAMC A 28112 (2, juv.)
Ophiocoma cf. *dentata*	Sodwana Bay	20	RMCA MT 2380 (1)
Ophiocoma doederleini	Bhanga Nek (Saxon Reef)	20	RMCA MT 2249 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2250 (1)
	Bhanga Nek	16	RMCA MT 2203BIS (2)
Ophiocoma erinaceus	Sodwana Bay (5-mile Reef)	18	RMCA MT 2136 (3)
	Bhanga Nek (Saxon Reef)	20	RMCA MT 2142 (2)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2253 (1)
	Bhanga Nek	20	RMCA MT 2155 (1, juv.)
	Sodwana Bay (1/4-mile Reef)	10	RMCA MT 2220 (1, juv.)
	Sodwana Bay (7-mile Reef)	17	RMCA MT 2349 (1)
Ophiocoma pica	Qolora, Eastern Cape	Intertidal	SAMC A 23248 (2)
Ophiocoma pusilla	Aliwal Shoal	20	RMCA MT 2345 (1)
	Sodwana Bay (2-mile Reef)	13	RMCA MT 2219 (1)
	Sodwana Bay (2-mile Reef)	13	RMCA MT 2200 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2346 (1)
	Bhanga Nek	20	RMCA MT 2337 (1)
	Sodwana Bay (2-mile Reef)	15	RMCA MT 2217 (1)
	Sodwana Bay (2-mile Reef)	14	RMCA MT 2214 (1)
	Aliwal Shoal	16	RMCA MT 2218 (1)
	Sodwana Bay (Deep sponge)	32	RMCA MT 2380 (1)
	Aliwal Shoal	13	RMCA MT 2153 (1)
	Sodwana Bay (2-mile Reef)	10	RMCA MT 2221 (1)
	Sodwana Bay (2-mile Reef)	10	RMCA MT 2149 (1)
	Sodwana Bay (2-mile Reef)	14	RMCA MT 2381 (1)
Ophiocoma scolopendrina	Umgazana, Eastern Cape	?	SAMC A 23093 (2)
Ophiocoma valenciae	Park Rynie	Intertidal	RMCA MT 1754 (3)
	Park Rynie	Intertidal	RMCA MT 1755 (1)
	Sodwana Bay (5-mile Reef)	18	RMCA MT 1748 (1)
	Sodwana Bay (5-mile Reef)	16	RMCA MT 1749 (1)
	Sodwana Bay (5-mile Reef)	18	RMCA MT 1750 (3)
	Aliwal Shoal	16	RMCA MT 1756 (1)
	Aliwal Shoal	13	RMCA MT 1751 (1)
	Aliwal Shoal	13	RMCA MT 1753 (1)
	Aliwal Shoal	13	RMCA MT 1752 (1)
	Aliwal Shoal	13	RMCA MT 1747 (1)
	Durban	Intertidal	SAMC A 23250 (1)
	Durban	Intertidal	SAMC UCT ECOL COLL. D 178(1)
	Port St Johns	Intertidal	SAMC MEIRING NAUDE COLL. J 9_1 (6)
	Umhlali	Intertidal	SAMC UCT ECOL COLL. U 23A (1)

TAXONOMIC ACCOUNT

A taxonomic description and detailed geographical distribution for *Ophiocoma* species that are new records for South Africa is given. For the other well-known species, only a summary and the citations of major works which provide detailed information on their taxonomy and distribution is provided.

Order Ophiurida Müller and Troschel, 1840

Family Ophiocomidae Ljungman, 1867

Genus *Ophiocoma* Agassiz, 1836

(Type species *Ophiura echinata* Lamarck, 1816 (by subsequent designation of Clark, 1915)).

Diagnosis *(after Devaney, 1970*: *9; Clark and Courtman-Stock, 1976*: *172-173).*
Majority of species large with D.D. often exceeding 20mm; three to seven generally smooth, stout arm spines, sometimes alternating three and four on successive arm segments, or on opposite sides of same segment; lower arm spines sometimes flattened and spatulate, while upper ones cylindrical or cigar-shaped. Disc generally covered with granules, occasionally concealing scaling on disc and sometimes extending into ventral interradial regions. Oral shields without granules or spines, triangular with three to four, rarely five, contiguous oral papillae, outer one usually widest. Tooth papillae always present, few to numerous, with superficial ones in series with oral papillae. Oral shields large, oval, hexagonal or pentagonal.

When distal lobe angular, proximal end usually more or less truncated to match interradial separation of adoral shields. Dorsal arm plates wider than long, fan-shaped, oval or hexagonal. Ventral arm plates more or less square-shaped, proximal side straight, distal side straight to concave. Two tentacle scales, at least in first arm segments, sometimes only one towards tip.

Ophiocoma brevipes **Peters, 1851 [=*Ophiocoma* (*Breviturma*) *brevipes*]**
(Plate 3.1A-G, 3.2A-C)

Ophiocoma brevipes Peters, 1851: 466; Marktanner-Turneretscher, 1887: 303; De Loriol, 1893a: 25, 26, pl. 23, fig. 4; Clark, 1908: 296; Clark, 1911: 256; Koehler, 1922b: 319-322, pl. 72, figs 6-9; Devaney, 1968: 45; Devaney, 1970: 13; Clark and Rowe, 1971: 86, 119; Devaney, 1974: 151-152; Cherbonnier and Guille, 1978: 168-169, pl. X, figs 3, 4; Sloan *et al.*, 1979: 104; Clark, 1980: 534; Tortonese, 1980: 125, fig. 11; Humpreys, 1981: 10, 23; James, 1982: 39-40, pl. 2B; Clark, 1984: 100; Rowe and Gates, 1995: 385; Rowe and Richmond, 2004: 3292.

Location and status of types - ZMB Ech 961 (1 syntype), ZMB Ech 962 (1 syntype), ZMB 963 (1 syntype), ZMB Ech 4660 (3 syntypes).
Type locality - Coast of Mozambique (ZMB Ech 961-963); Quirimba Island, Mozambique (ZMB Ech 4660).

Material examined
Over 150 individuals of *O. brevipes* from South Africa and Madagascar were examined. On seven of them, one to three smaller individuals were attached in such a way that they had their arms slotted in the genital slit. These are here tentatively treated as juvenile *O. brevipes*.

Adults
D.D. = 5.6-25.2mm; D.D./A.L. from 1/3.2 to 1/4.8. Disc colour patterns variable with a combination of light greens, whites, yellows and browns in blotchy star or simply no particular pattern. Disc with small, fine, spherical granules closely packed on both dorsal and ventral side (Plate 3.1A, 3.1B). Oral shields with darker markings, but with no apparent pattern. Dental plate (Plate 3 . 1G) between 1.9 and 2.1 times longer than wide, with a wide vertical septum between each oval, slightly elongated tooth foramen, dental papillae region limited to approximately 27% of dental plate length. Genital slits clearly visible, elongated and bordered with slightly more prominent granules. Arms appear banded (darker) on the dorsal side, some specimens with light dots or specks on ventral side of each arm plate along the length of arm. Ventral arm plates nearly as wide as long, bluntly pointed on the proximal side. Dorsal arm plates fan-shaped, much wider than long. Uppermost spines thickest on proximal part of arm. Longest arm spine less than or equal to breadth of dorsal arm plate. Two tentacle scales.

Juveniles

D.D. = 1.5-4.3mm; D.D./A.L. from 1/1.8 to 1/2.8. Disc colour brown-grey, both dorsally (Plate 3.1E) and ventrally (Plate 3.1F). Dorsal side of disc marked with five radial pairs of bowed brown lines extending from the margin, passing through radial shields and almost reaching centre of disc (Plate 3.1E). One specimen has a faint white dot in the centre of its disc. Radial shields oval, exposed, minute in size, hardly visible and similar in colour to disc. Disc circular in outline and moderately convex, covered dorsally and ventrally by imbricated scales of different sizes and shapes. Disc scales hardly visible dorsally but obvious ventrally. Disc granulation absent on ventral and dorsal surfaces. Oral shields and adoral shields uniformly brownish. Oral shields pear-shaped, sometimes with a thickened distal side, hardly longer than broad. Adoral shields triangular, almost touching proximally. Jaws triangular with three to four hyaline-tipped, somewhat pointed oral papillae on each oral plate. Dental plate with one to two teeth and three to four hyaline-tipped dental papillae; lowermost two to three forming a cluster at apex of jaw angle (Plate 3.1F). Dental plate (Plate 3.2A) 1.6 times longer than wide, with a thin vertical septum between each oval, slightly elongated tooth foramen, dental papillae region limited to approximately 28% of dental plate length. Genital slits unarmed, almost reaching margin of disc. Dorsal arm plates uniformly brown and fan-shaped, first two to four plates contiguous, thereafter well-separated. Ventral arm plates uniform brownish-grey. First two ventral arm plates slightly broader than long with straight distal edge; thereafter plates gradually become longer, almost rectangular in shape with distal edge gradually becoming more concave. Arm spines light brown with dark longitudinal line dorsally (Plate 3.2B). Arm spines longer than length of arm plates, two on first segment, three on segments two to five, thereafter alternating two and three spines on segments six to nine, and two on further distal segments, hyaline and ragged structure. Distally, arm spines with multifid claw-like hooks (Plate 3.2C). Single tentacle scale over whole arm length apart from largest juvenile (D.D. = 4.3mm) with two tentacle scales on first two segments.

Geographical distribution

Tropical Indo-West Pacific region, but absent in Red Sea, Persian Gulf and north-western parts of Indian Ocean (Rowe and Richmond, 2004). Prior to this study, the only record from southern Africa was from Mozambique (Quirimba Archipelago) (Clark and Rowe, 1971). Thus the present record extends the range to Aliwal Shoal, some 60km south of Durban, South Africa. Juveniles were found on adults from South Africa, Madagascar and Glorioso Islands.

Ecology

Ophiocoma brevipes is associated with coral heads or boulders, on fine to coarse sand and at the base of algal plants in the sandy littoral zone (between 0-54m depth, cf. Lane *et al.*, 2000). An overview of known microhabitats of *O. brevipes* is presented in Sloan *et al.* (1979).

On one living adult, the juvenile was observed to partially move into the genital slit of the adult after collection (Plate 3.1C, D).

Remarks

The complete absence of granulation on the disc and the loose meshwork structure of the dental plate indicate that the specimens attached to the adult *O. brevipes* are most probably juveniles. The colour pattern of these juveniles somewhat resembles a juvenile *Ophiomastix venosa,* which is known to attach itself to *Ophiocoma scolopendrina* (Fourgon *et al.*, 2007). However, based on the descriptions by Fourgon *et al.* (2007) and Cherbonnier and Guille (1978), it can be ruled out that the nine specimens studied here are juvenile *Ophiomastix venosa*, because (i) arm spines of *O. venosa* are distinctly longer, are glassy and thin; (ii) jaws of *O. venosa* are much more elongated and (iii) ventral arm plates of *O. venosa* taper more proximally.

The proximally extended adoral shields which nearly meet around the oral shield are indicative of *Clarkcoma* Devaney, 1970 and the alternating number of arm spines, with the uppermost spine enlarged (approximately two segments long) suggests an affinity with Devaney's (1970) *Scolopendrina* Group. On the other hand, the appressed morphology of the dental plates is indicative of Devaney's (1970) *Brevipes* Group and, therefore, it is believed the juveniles here are *O. brevipes*. If this identification can be confirmed with complementary studies, such as molecular systematics, this would present a new case of parental care.

The tips of the arms in the juveniles were found to bear hooks that may assist in gripping (see Plate 3.2C). In addition to the hooks, the spines have a ragged structure that could also assist in clinging to the adult (see Plate 3.2B). Hooked spines have been also been observed in ophiuroid species with an epizoic lifestyle (Hyman, 1955).

Ophiocoma cf. *dentata* Müller & Troschel, 1842 [=*Ophiocoma* (*Breviturma*) *dentata*]

(Plate 3.2D, E)

Ophiocoma dentata Müller and Troschel, 1842: 99, pl. 7, figs 3, 3a; Devaney, 1968: 45; Devaney, 1970: 13; Clark and Rowe, 1971: 86, 119, pl. 18, figs 2-3; Cherbonnier and Guille, 1978: 168, pl. C, figs 3, 4; Tortonese, 1980: 125, fig. 11A, B; James, 1982: 40, pl. 2C, D; Rowe and Gates, 1995: 386; Price and Rowe, 1996: 76; Rowe and Richmond, 2004: 3292.
Ophiocoma insularia Lyman, 1862: 80-81; Macnae and Kalk, 1958: 130.

Location and status of types - ZMB Ech 931 (holotype, fixed by monotypy).
Type locality - Unknown, according to Müller and Troschel (1842: 99). However, the ZMB has only one specimen of *Ophiocoma dentata* in its collection. The catalogue indicates that this specimen was deposited by Deppe, just as is indicated by Müller and Troschel (1842), and that it comes from 'Celebes?'[3], currently known as the Islands of Sulawesi (Indonesia).

Material examined

D.D. = 14.3mm, variegated with brown, white and beige, both dorsally and ventrally with the presence of small dark brown spots. Oral shields round, as long as wide, with marbled pattern. Dental papillae broad, not extending far into mouth. Dorsal arm plates beige to brown, with a whitish-grey patch surrounded by dark brown border on the median distal side, broad and elliptical. Lateral arm plates lighter with several spots. Ventral arm plates light with same spots; sometimes a dark-coloured patch is present centrally, square with rounded corners, as wide as long. Arm spines white to beige, broadly and irregularly banded once or twice with light brown. Upper arm spines thick, blunt, somewhat flattened and slightly shorter than the lower ones. Tentacle scales, two.

Ecology

According to Devaney (1970), this species frequents the sub-littoral zone, under boulders or associated with coral and coral debris on a sand or rubble substratum.

Geographical distribution

Ophiocoma dentata has a tropical, Indo-West Pacific distribution (with the exception of the Red Sea and north-western Indian Ocean (Rowe and Gates, 1995; Rowe and Richmond, 2004). Prior to this study

[3] Müller & Troschel (1842) give no indication that they had more than one specimen before them, hence ICZN Art 73.2.2 applies.

the most southern records originated from Inhaca Island (Mozambique) (Macnae and Kalk, 1958; as *O. insularia* Lyman, 1862).

Remarks

This specimen, at first examination, bears resemblance to *Ophiocoma brevipes*. Devaney (1970) pointed out three means by which *O. brevipes* can be separated from *O. dentata* (and *O. doederleini*; see here under) for specimens of similar size. First, by comparing the arm spine sequence: while *O. brevipes* presents five arm spines on segments four to seven, five to six arm spines up until segment 11, and two to three arm spines thereafter, *O. dentata* has only four (occasionally five) arm spines on segments four to seven, four arm spines up until segment 13 and three arm spines thereafter. Secondly, in *O. brevipes* the longest arm spine rarely exceeds the breadth of the ventral arm plate, while in *O. dentata* (and *O. doederleini*) the longest arm spine greatly exceeds the ventral arm plate. Thirdly, by comparing the pigmentation: while *O. brevipes* has a uniform white or cream colour on the oral side of arms and the oral plates and shields, the other two species have a more grey, brown or variegated colouration.

However, specimens here differ somewhat from the typical *Ophiocoma dentata* as reported by Devaney (1970). First, the arm spine sequence of the examined specimen has three arm spines on its four first segments, segments five to 15 have four arm spines, and thereafter three arm spines, which differs from the arms of *O. dentata* where five arm spines on segment seven were not observed. Second, the colouration of the dorsal arm plates is beige to brown with a whitish-grey patch that is bordered by dark brown on the median distal side, which differs from the description given by Devaney (1970, fig. 21). Finally, the white to beige arm spines are broadly and irregularly annulated with light brown. Given these three differences, a single specimen should not be used to describe a new species until more material becomes available.

Ophiocoma doederleini de Loriol, 1899 [=*Ophiocoma* (*Breviturma*) *doederleini*]

(Plate 3.2F, G and Plate 3.3A, B)

Ophiocoma doederleini De Loriol, 1899: 30, pl. 3, fig. 2; Devaney, 1968: 69; Devaney, 1970: 12-18, figs 18, 14, 22, table 2B, 3; Devaney, 1974: 154; Sloan *et al.*, 1979: 104, figs 8-10; Clark, 1980: 534; Humpreys, 1981: 10, 24; Clark, 1984: 100; Rowe and Gates, 1995: 396.
Ophiocoma dentata Lütken, 1859: 267 (non Müller & Troschel 1842); Clark, 1921: 121.

Location and status of types - MHNG INVE 71892 (holotype).
Type locality - Mauritius.

Material examined

The specimens collected represent the two known colour forms (Devaney, 1970; Sloan *et al.*, 1979). Whole specimens greyish-brown dorsally and ventrally (Plate 3.2F, G). Disc greyish-brown with fine black reticulating lines, white-ringed black spots, or speckled with light spots. Spots, speckles and lines do not outline the shape of radial shields, thus radial shields are not conspicuous (Plate 3.3A, B). Oral shields large, round to oval in shape, white on edges and often with large, irregular grey blotches. Dental papillae broad but lowermost shorter than others. Ventral side of arms brown with spotted white bands, or with dark bands, with narrower bands in between which continue down the arm. Arm spines taper, annulated white and / or grey. Combination of two and three tentacle scales on arms.

Ecology
All specimens were present under large boulders over gravel. Rowe and Gates (1995) record it as a benthic, inshore, littoral species. An overview of known microhabitats of *Ophiocoma doederleini* is presented in Sloan *et al.* (1979).

Geographical distribution
Indian Ocean and west central Pacific Ocean (Rowe and Gates, 1995). Specimens in this study, represent a new record for southern Africa.

Remarks
Devaney (1970: 15-16, Table 2b) provides an accurate means to separate *Ophiocoma dentata* from *O. doederleini*: annulation of the arm spines is easily used in the field and is absent in *O. dentata* but present in *O. doederleini*.

Ophiocoma erinaceus Müller & Troschel, 1842
(Plate 3.3C, D)

Ophiocoma erinaceus Müller and Troschel, 1842: 98; Devaney, 1968: 173 (synonymy[4]); Devaney, 1970: 33, figs 45-47; Kalk, 1958: 207, 216, 237; Clark, 1967: 47; Clark and Rowe, 1971: 86, 119, pl. 17, figs 5, 6; Clark and Courtman-Stock, 1976: 122, 173; Cherbonnier and Guille, 1978: 169, pl. 10, figs 5, 6; Sloan *et al.*, 1979: 106, figs 11, 12; Clark, 1980: 535, 548; Tortonese, 1980: 124; Humpreys, 1981: 10, 24; James, 1982: 38, pl. 1D; Price, 1982: 8; Clark, 1984: 100; Rowe and Gates, 1995: 387; Price and Rowe, 1996: 77; Rowe and Richmond, 2004: 3292; O'Hara *et al.*, 2004: 537-541; Benavides-Serrato and O'Hara, 2008: 51; Reza Fatemi *et al.*, 2010: 44, fig. 2.
Ophiocoma similanensis Bussarawit and Rowe, 1985: 1, figs 1, 2; Price and Rowe, 1996: 77.

Location and status of types - ZMB Ech 921 (syntype 1); ZMB Ech 922 (syntype 2); ZMB Ech 923 (syntype 3), specimen lost; ZMB Ech 924 (syntype 4), specimen lost.
Type locality - Red Sea and Indian Ocean.

Material examined
D.D. = 2.8-21.5mm. Specimens characteristically black, dark brown or dark red dorsally and lighter ventrally. Some of the specimens under study were juveniles, as evident from pigmentation of dorsal disc (pairs of cream lines starting at the margin, passing through radial shields and almost reaching centre of disc; Plate 3.3D), the arm spines (edge lighter) and armament of the disc (disc dorsally and ventrally devoid of granules) (see also Cherbonnier and Guille, 1978: 171; Bussarawit and Rowe, 1985, as *Ophiocoma similanensis*). Oral shields pear-shaped, broadest distally. Dorsal arm plates uniform black, fan-shaped, distally convex, overlapping as tiles on a roof, more than twice as wide as long. Ventral arm plates uniform brown, from regular hexagons proximally to pentagons distally. Two equal-sized tentacle scales over the complete arm. Three to four arm spines, with uppermost one always largest. Three specimens had longitudinal stripes on arm spines similar to the juveniles of this species. Tube feet of live specimens reddish. Arm spines on most specimens flattened close to disc.

Ecology
Benthic, inshore (Rowe and Gates, 1995) from 0-27m depth (Lane *et al.* 2000). Associated with coral (Clark and Courtman-Stock, 1976; Humpreys, 1981; Bussarawit and Rowe, 1985; Stöhr *et al.*, 2008) and often found on gravel under boulders. Juveniles found on an encrusting turret sponge

[4] Cherbonnier & Guille (1978) removed *O. schoenleinii* Müller & Troschel, 1842 - characterized by the presence of just one tentacle scale, not two as in *O. erinaceus* - from Devaney's synonymy. In this study, Cherbonnier & Guille (1978) were followed.

(*Haliclona* sp.), or under dead coral boulders An overview of known microhabitats of *Ophiocoma erinaceus* is presented by Sloan *et al.* (1979).

Geographical distribution

Tropical to subtropical Indo-Pacific region.

Remarks

Even though *O. erinaceus* is one of the most abundant and conspicuous brittle stars in littoral tropical seas, its taxonomy has only recently been elaborated. O'Hara *et al.* (2004) used molecular, morphological and day / night colour change data to show that *O. erinaceus* is a species complex of three species: *O. erinaceus*, *O. schoenleinii* Müller and Troschel, 1842 and a third undescribed species. The last was formally described and named *O. cynthiae* by Benavides-Serrato and O'Hara in 2008. Species in the complex can be distinguished from one another by: (i) colouration of tube feet (red in live or white in preserved *O. erinaceus*; grey in life and preserved *O. cynthiae* and *O. schoenleinii*), (ii) number of tentacle scales (one in *O. schoenleinii*; two in *O. erinaceus* and *O. cynthiae*); (iii) granulation of the ventral side of the disc (largely absent in *O. cynthiae*, as a wedge near the margin in *O. schoenleinii* and extending almost to the oral shields in *O. erinaceus*); and (iv) the size and morphology of the dental plates. Price and Rowe (1996) recognised that their *O. similanensis* Bussarawit and Rowe, 1985 is but a juvenile *O. erinaceus* and described growth changes for specimens ranging from a D.D. of 3.6-22.2mm. The juveniles in this study match the description of *O. similanensis* very well.

***Ophiocoma pica* Müller & Troschel, 1842**

(Plate 3.3E, F)

Ophiocoma pica Müller and Troschel, 1842: 101; Clark, 1921: 127, pl. 13, fig. 8; Clark, 1938: 333; Balinsky, 1957: 25-26; Devaney, 1968: 131; Macnae and Kalk, 1958: 130; Devaney, 1970: 19, figs 20, 23, 24, 25, 27; Clark and Rowe, 1971: 86-87, 118; Clark and Courtman-Stock, 1976: 173; Cherbonnier and Guille, 1978: 172, pl. 11, figs 5, 6; Sloan *et al.*, 1979: 106, Clark, 1980: 535, 548; Tortonese, 1980: 124; Price, 1982: 8; Clark, 1984: 100; James, 1982: 36-38, pl. 1C; Rowe and Gates, 1995: 387; Price and Rowe, 1996: 77.

Location and status of types - Unknown; placed in MNHN according to Müller and Troschel (1842:101) and according to the MNHN catalogue, but not in MNHN according to Nadia Améziane (pers. comm.).
Type locality - Unknown, according to Müller and Troschel (1842). The senior subjective synonym (Lyman, 1865) *Ophiocoma lineolata* Desjardins in Müller and Troschel (1842) stems from Mauritius.

Material examined

D.D. = 5.3mm (D.D./A.L = 1/4). Disc covered dorsally with spherical granules extending onto distal parts of ventral interradii. Colour pale yellow (after preservation in alcohol). Oral shields mainly oval; adoral shields triangular, not contiguous proximally; oral papillae three to four, dental papillae six to ten; teeth one or two, slightly elongated and blunt. Genital papillae present, cone-shaped. Dorsal arm plates fan-shaped, convex on distal side and concave on proximal side, hardly changing shape distally. Ventral arm plates straight to slightly convex on distal side, concave proximally, plates becoming slightly longer distally. Arm spines five proximally and four distally, slender, second spine longest, about two times segment length, lower arm spines same length as segment or slightly longer. Tentacle scales two, inner one slightly smaller proximally.

Ecology

Benthic, inshore (Rowe and Gates, 1995), 0-24m (Lane *et al.*, 2000). Usually associated with coral (Clark, A.H., 1952; Devaney, 1968; 1970; Clark and Courtman-Stock, 1976; Price and Rowe, 1996),

but also found under rock or dead coral rubble (Devaney, 1970). An overview of known microhabitats of *Ophiocoma pica* is presented by Sloan *et al.* (1979).

Geographical distribution
Widely distributed throughout Indo-Pacific region (Clark, 1921; Clark and Rowe, 1971).

Remarks
Given the material from South Africa was in a poor state, a specimen from Mahé (Seychelles) was chosen to be illustrated (Plate 3.3E, F). The record discussed here presents a range extension from Richards Bay to Qolora (Eastern Cape Province). Colour in life dark brown or black with radiating golden lines on disc and, often, transverse bands annulating the arms.

Ophiocoma pusilla (Brock, 1888)
(Plate 3.4A, B)

Ophiomastix pusilla Brock, 1888: 499; Devaney, 1970: 25 (records before 1970).
Ophiocoma latilanxa Murakami, 1943a: 194-196; Murakami, 1943b: 218; Devaney, 1970: 25-27.
Ophiocoma pusilla (Brock, 1888); Clark, 1921: 131; Devaney, 1970: 25, figs 26, 29; Clark and Rowe, 1971: 86-87, 118; Clark and Courtman-Stock, 1976: 122, 174, fig. 190; Cherbonnier and Guille, 1978: 173-174, pl. 11, figs 3, 4; Sloan *et al.*, 1979: 106; Clark, 1980: 535, 544; Tortonese, 1980: 127; Humpreys, 1981: 10, 24; Price, 1982: 8; Clark, 1984: 100; Rowe and Gates, 1995: 388; Price and Rowe, 1996: 77.

Location and status of types - ZMB Ech 5429 (lectotype); ZMB Ech 4777 (paralectotype).
Type locality - Ambon, Indonesia.

Material examined
D.D. = 3.3-7.7mm. Disc of one specimen slightly speckled, while another had banded arms from half-way down arms to the tips. Dorsal disc with uniformly distributed granules concealing radial shields. Ventral disc with same type of granules, leaving bare only a narrow V-shaped interbrachial area. Oral shields oval, nearly twice as long as wide. Adoral shields triangular, not touching proximally. Four to five oral papillae per jaw. Dental papillae in two to three rows. Dorsal arm plates proximally fan-shaped, wider than long, with convex distal side touching the next plate only for about a third of its width; distally plates longer than wide and less contiguous. Ventral arm plates fan-shaped, broader than long, though distally becoming longer than broad. Four to five arm spines, hollow, glassy and about 2.5 times segment length. Second uppermost arm spines at a third of arm length with pustular distal expansions, while other arm spines taper (cf. also Clark & Rowe, 1971). Tentacle scales two.

Ecology
Benthic, inshore (Rowe and Gates, 1995), 0-20m depth according to Lane *et al.* (2000), with the deepest specimen in this study found at 32m depth. Known to occur in sand channels, under rubble and associated with coral (Clark and Courtman-Stock, 1976; Humpreys, 1981; Price and Rowe, 1996). An overview of known microhabitats of *Ophiocoma pusilla* is presented by Sloan *et al.* (1979).

Geographical distribution
Ophiocoma pusilla has a tropical Indo-West Central Pacific Ocean distribution (Rowe and Gates, 1995), including the Red Sea (Clark, 1967 (as *Ophiomastix pusilla*); Price, 1982). In southern Africa, this species was reported from Mozambique (Clark and Courtman-Stock, 1976).

Remarks
After examination of the size, shape and sequence of the arm spines, nature of the dental plates and oral shields and number of dental papillae, Devaney (1970) concluded that *Ophiocoma latilanxa*

Murakami, 1943, is a junior synonym of *O. pusilla*. In 1989, Soliman, ignored this when he identified *O. latilanxa*[5] from the Red Sea. In 1991, a new species, *Ophiocoma aegyptiaca* Soliman, 1991 was described from the same area and Soliman (1991) continued to treat *O. latilanxa* as a valid species and noted that his new species bears close resemblance to *O. schoenleinii* and *O. latilanxa* (=*O. pusilla*). Although the type material was not examined, it is suspected that *O. aegyptiaca* and *O. latilanxa* (=*O. pusilla*) will prove to be synonyms.

According to Soliman (1991), the differences between *O. aegyptiaca* and *O. latilanxa* consist mainly of: (i) the colour pattern of the disc and the plates (the present specimens of *O. pusilla* show that the colouration is very variable (disc uniform brown to reticulate to spotted with dark blotches; spines uniformly coloured to spotted)); (ii) the shape of the oral shields (although Soliman (1991) states that the oral shields of *O. aegyptiaca* are trapezoidal he drew them oval (fig. 3A, p. 82 & p. 85), similar to the ones of *O. pusilla*); (iii) the number of arm spines (maximum five in *O. aegyptiaca*, except Soliman (1991) does not give the sequence of the arm spines; the present *O. pusilla* specimens mostly have arm spine sequences: 3-3-4-4-4(or 5)-5-4-5). On the other hand the form and size of the dorsal arm plates are very similar for *O. aegyptiaca* and *O. pusilla* (compare Devaney, 1970: fig. 29, p. 21 with Soliman, 1991: fig. 4, p. 83).

Ophiocoma scolopendrina (Lamarck, 1816)

(Plate 3.4C, D)

Ophiura scolopendrina Lamarck, 1816: 544.
Ophiocoma scolopendrina (Lamarck, 1816): Kalk, 1958: 205; Macnae and Kalk, 1958: 130; Devaney, 1968: 203; Devaney, 1970: 33-35; Clark and Rowe, 1971: 86, 119, pl. 17, figs 3, 4; Clark and Courtman-Stock, 1976: 122, 174; Sloan *et al.*, 1979: 106, fig. 13; Clark, 1980: 535; Tortonese, 1980: 124; Price, 1982: 8; James, 1982: 36-39, pl. 2A; Rowe and Gates, 1995: 388; Reza Fatemi *et al.*, 2010: 45, fig. 3.

Location and status of types - Unknown for *O. scolopendrina*, not in the MNHN (Marc Eleaume, pers. comm.). According to Devaney (1968), type specimens are present in the Dorpat Museum as the junior subjective synonym *O. variabilis* Grube, 1857 (from 'Waohu Island' - Oahu Island?) and in the Museum of Comparative Zoology as the junior subjective synonym *O. molaris* Lyman, 1861 (from 'Kingsmill Islands' = Gilbert Islands, Kiribati).
Type locality - Recorded by Lamarck (1816) as Mauritius ('Ile de France'). The ZMB holds two syntypes of a junior synonym, *O. alternans* Von Martens, 1870, from Java.

Material examined

Given that current synonymy might lead to some confusion in its distribution, it was felt appropriate to establish a neotype from the original type locality, Mauritius.

Type material

Neotype *Ophiocoma scolopendrina* (Lamarck, 1816), here designated: MNHN EcOh 11043 (specimen with D.D. = 23.8mm), Mauritius, coll. M. Carié, 1913.

Disc uniformly brown both dorsally and ventrally, although where granules have been worn off, lighter patches visible. Dorsal arm plates blotched with brown on beige, giving arms a variegated to banded pattern. Oral and adoral shields with similar blotching. Arm spines uniform in colour (light brown ventrally and somewhat darker dorsally), although on rare occasions some banding can be observed on uppermost spines. Disc pentagonal with interradial margins straight to slightly indented.

[5] Soliman (1989) misspelled *Ophiocoma latilanxa* as *O. latilanaxa*

Dorsal disc densely covered with spherical granules, covering the whole surface including the radial shields, which cannot be distinguished. Ventral disc with same, densely distributed granules, but less dense closer to genital slit, which is bordered by a fringe of elongated genital papillae. Oral shields oval, shorter (2.5mm) than wide (3.0mm). Adoral shields restricted to lateral edge of oral shield, triangular but with other margin curved, not touching proximally. Five oral papillae on each oral plate, inner ones more pointed than outer, wider ones; oral tentacle scale very low and wide. Four to nine dental papillae, placed in a cluster below wide truncated teeth. Dorsal arm plates fan-shaped, wider than long with distal margin straight in first segments, becoming more convex in distal segments, plates contiguous throughout the arm. First two ventral arm plates distinctly smaller than rest, with distal margin indented, lateral margins convex and proximal margin straight, about as long as wide. Subsequent ventral arm plates significantly larger, wider then long, with convex distal margin and concave proximal margin which is only slightly overlain by preceding plate, laterally plates recurved around tentacle pore. Arm spines three to five (three on segment three, four to five on segment eight), uppermost ones thick, short, but longer than dorsal arm plates; lower arm spines more slender, always longer than dorsal arm plates, except for first two segments. Arm spines uniform in colour (light brown ventrally and somewhat darker dorsally), although, on rare occasion, some banding can be observed on uppermost spines. Two oval tentacle scales, inner one a fraction longer, over the complete arm length.

Non-type material

To avoid damage to the neotype, another specimen was used to describe the dental plate, which is between 1.9 times longer than wide, with a very wide vertical septum between each oval, elongated tooth foramen; dental papillae region limited to approximately 20% of dental plate length.

Ecology

Benthic, inshore, littoral (Rowe and Gates, 1995), 0-13m depth (Lane *et al.*, 2000). An overview of known microhabitats of *Ophiocoma scolopendrina* is presented by Sloan *et al.* (1979).

Geographical distribution

Tropical, Indo-Pacific region (Rowe and Gates, 1995), including the Red Sea.

Remarks

As noted by Devaney (1968) and others*, O. scolopendrina* is often confused with *O. macroplaca* (Clark 1915), a Hawaiian endemic, and *O. erinaceus* Müller and Troschel, 1842. No *O. macroplaca* specimens were available for examination, so it is not possible to comment on Devaney's (1970) means of distinguishing it from *O. erinaceus* and *O. scolopendrina*. On the other hand, limited comparative study of the dental plates of *O. erinaceus*, and *O. scolopendrina* show that dental plate morphology can be used to recognise both species with certainty. The senior primary homonym, *Ophiocoma scolopendrina* Agassiz, 1836 (as for instance mentioned by Müller and Troschel, 1842), is to be considered a *nomen nudum.*

Ophiocoma valenciae Müller & Troschel, 1842

(Plate 3.4E, F)

Ophiocoma valenciae Müller and Troschel, 1842: 102; Devaney, 1968: 126; Eyre and Stephenson, 1938: 38, 43; Kalk, 1958: 200, 207, 237; Macnae and Kalk, 1958: 130; Clark, 1967: 44-45; Macnae and Kalk, 1969: 101, 106, 130; Clark and Rowe, 1971: 86, 119, pl. 18 fig. 1; Sloan *et al.*, 1979: 109, fig. 14; Clark, 1980: 535, 548; Tortonese, 1980: 125; Humpreys, 1981: 10, 24-25; Price, 1982: 8.

Location and status of types - ZMB Ech 4625 (syntype 1); ZMB Ech 955 (syntype 2).

Type locality - Aden.

Material examined

D.D. = 7.7-20.3mm. Disc colour brownish, arms tawny with darker bands; one specimen lacking darker bands on arms. Disc covered dorsally and ventrally with moderately fine granules, which become elongated towards margin of disc. Radial shields defined by lighter colour on some specimens, but could be an artefact of preservation. Dorsal arm plates broad, oval with up to six arm spines proximally. Uppermost arm spines shorter than middle spines, as long as arm width. Tentacle scale one.

Ecology

Associated with coral (Day, 1969) and sponges (Humpreys, 1981). Found within rocky crevices, cobbles, rubble and various algal beds (Humpreys, 1981). An overview of known microhabitats of *O. valenciae* is presented by Sloan *et al.* (1979).

Geographical distribution

Tropical Indian Ocean, including Red Sea and possibly the Persian Gulf (Clark and Rowe, 1971; Tortonese, 1980).

DISCUSSION

A total of 70 *Ophiocoma* specimens, belonging to eight species, were collected during the six expeditions to KwaZulu-Natal. *O. brevipes* was the most common (n = 24) followed by *O. pusilla* (n = 14) and *O. valenciae* (n = 14). Only a single individual of *O. dentata* was collected in South Africa. Although previously recorded in the Eastern Cape, no *O. pica* or *O. scolopendrina* were collected. *O. brevipes*, *O. doederleini*, *O. pusilla* and *O. dentata* are new records for South Africa. Even though Martynov (2010) warned that dental plates are to be used with caution as a taxonomic character, the dental plates permitted assignment of the juveniles collected here to the *Brevipes Group*, as suggested by Devaney (1970).

According to Hendler (1975), only 55 species of ophiuroids have been reported as viviparous, which is less than 3% of all known species. If the juveniles found attached to adult *O. brevipes* individuals are indeed also *O. brevipes* individuals, this report is the first account of brooding behaviour and parental care in *O. brevipes*. However, based on the examined material, it is concluded that free-living juveniles of *O. brevipes* must be very rare, which is in contrast to other ophiocomid species, such as *O. erinaceus,* which have been found as free-living (Price and Rowe, 1996). Reproductive experiments with *O. brevipes* populations from various locations will probably provide insight into the ontology and the reproductive strategy of *O. brevipes*.

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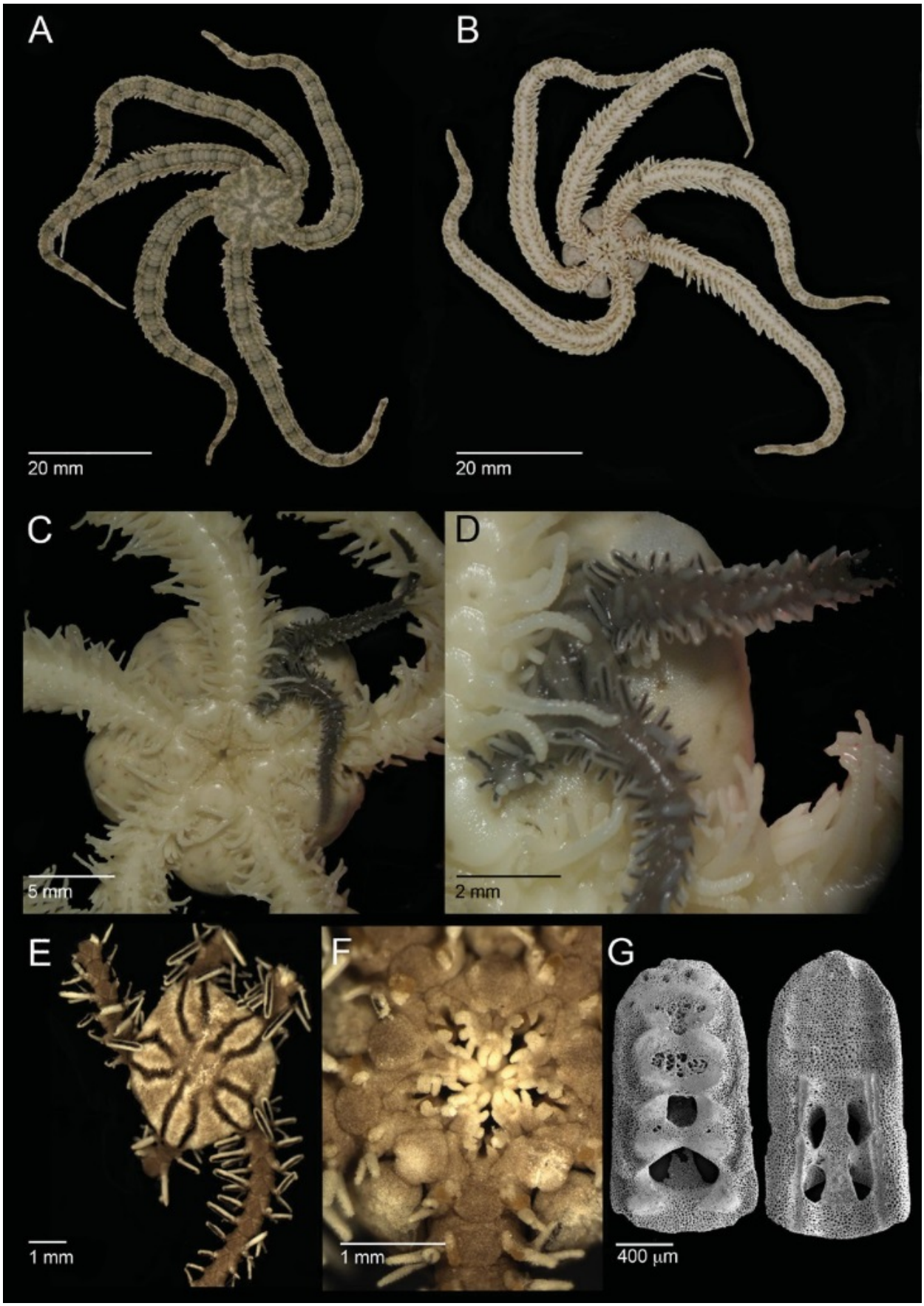

Plate 3.1. Dorsal (A) and ventral (B) views of *Ophiocoma brevipes*; position of juvenile *O. brevipes* within the genital slit of an adult *O. brevipes* (C & D); dorsal view of juvenile *O. brevipes* (E); ventral view of juvenile *O. brevipes* (F); dental plates (internal and external view) of adult *O. brevipes* (G).

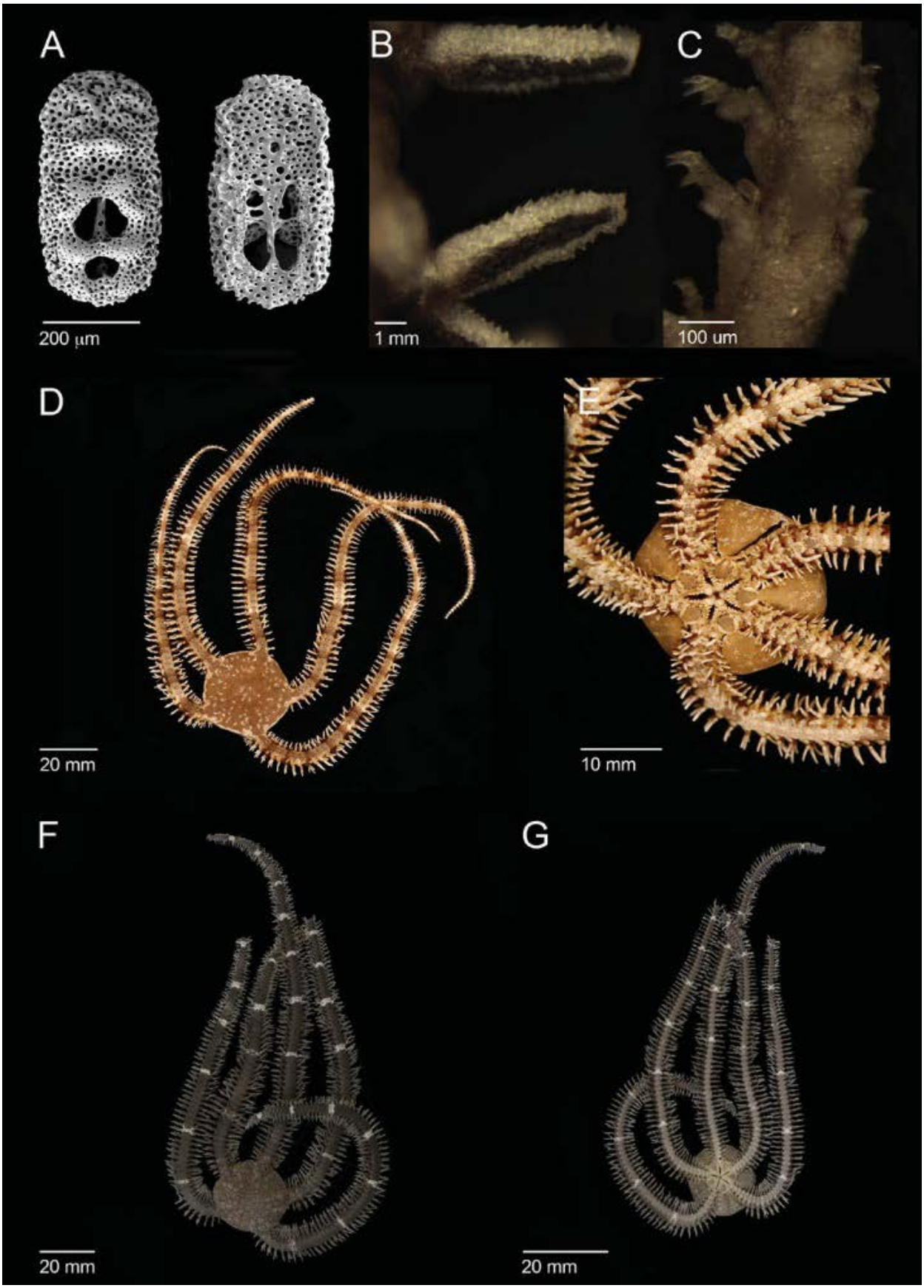

Plate 3.2. Dental plates of juvenile *Ophiocoma brevipes* (A); arm spines of juvenile *O. brevipes* (B); distal tip of arms of juvenile *O. brevipes* (C); dorsal view of *Ophiocoma* cf. *dentata* (D); ventral view of *O*. cf. *dentata* (E); dorsal view of *Ophiocoma doederleini* (F); ventral view of *O. doederleini* (G).

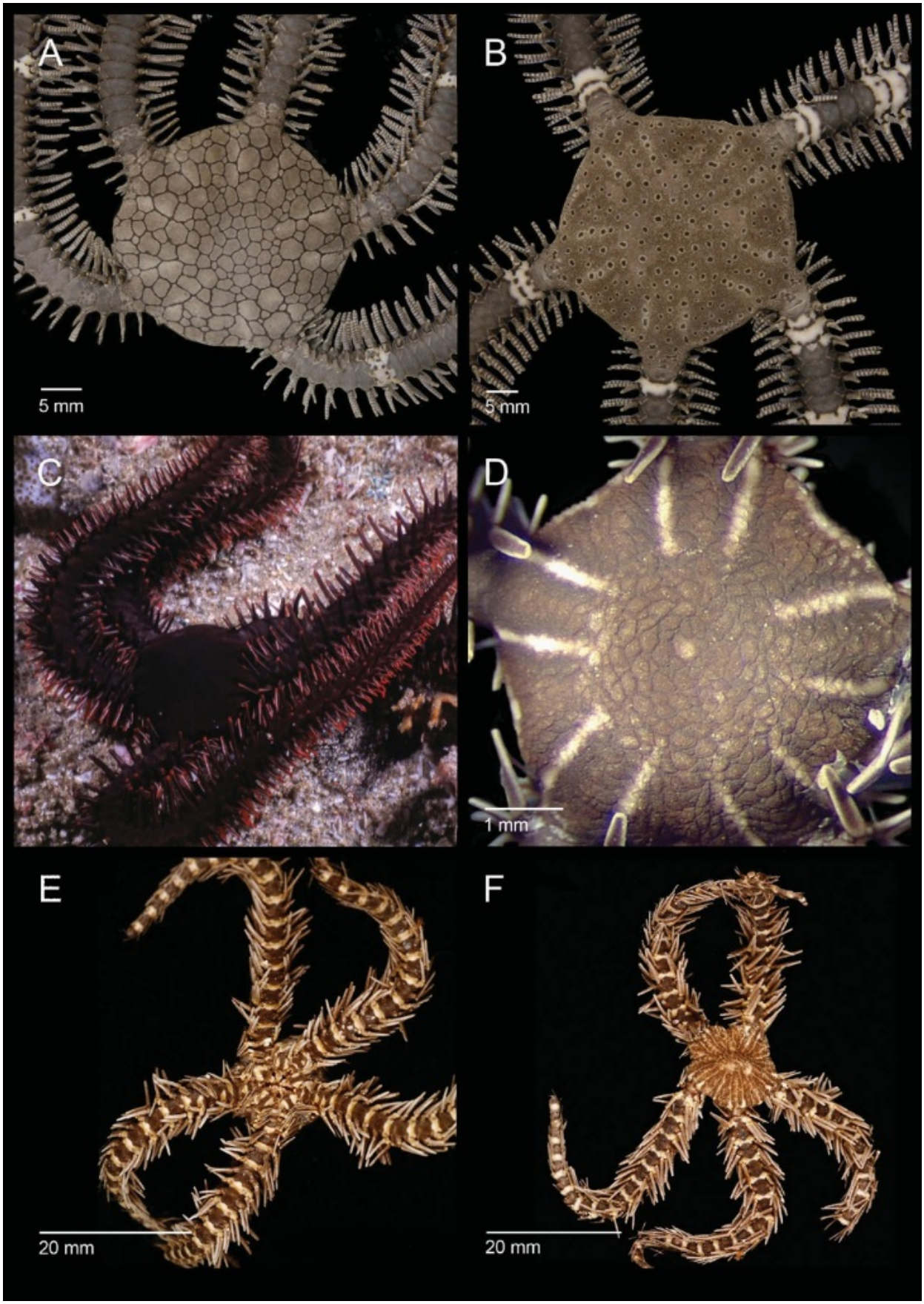

Plate 3.3. Dorsal views of reticulated (A) and spotted (B) forms of *Ophiocoma doederleini*; dorsal view of *Ophiocoma erinaceus* (C); dorsal view of juvenile *O. erinaceus* (D); ventral (E) and dorsal (F) views of *Ophiocoma pica* (from Mahé, Seychelles).

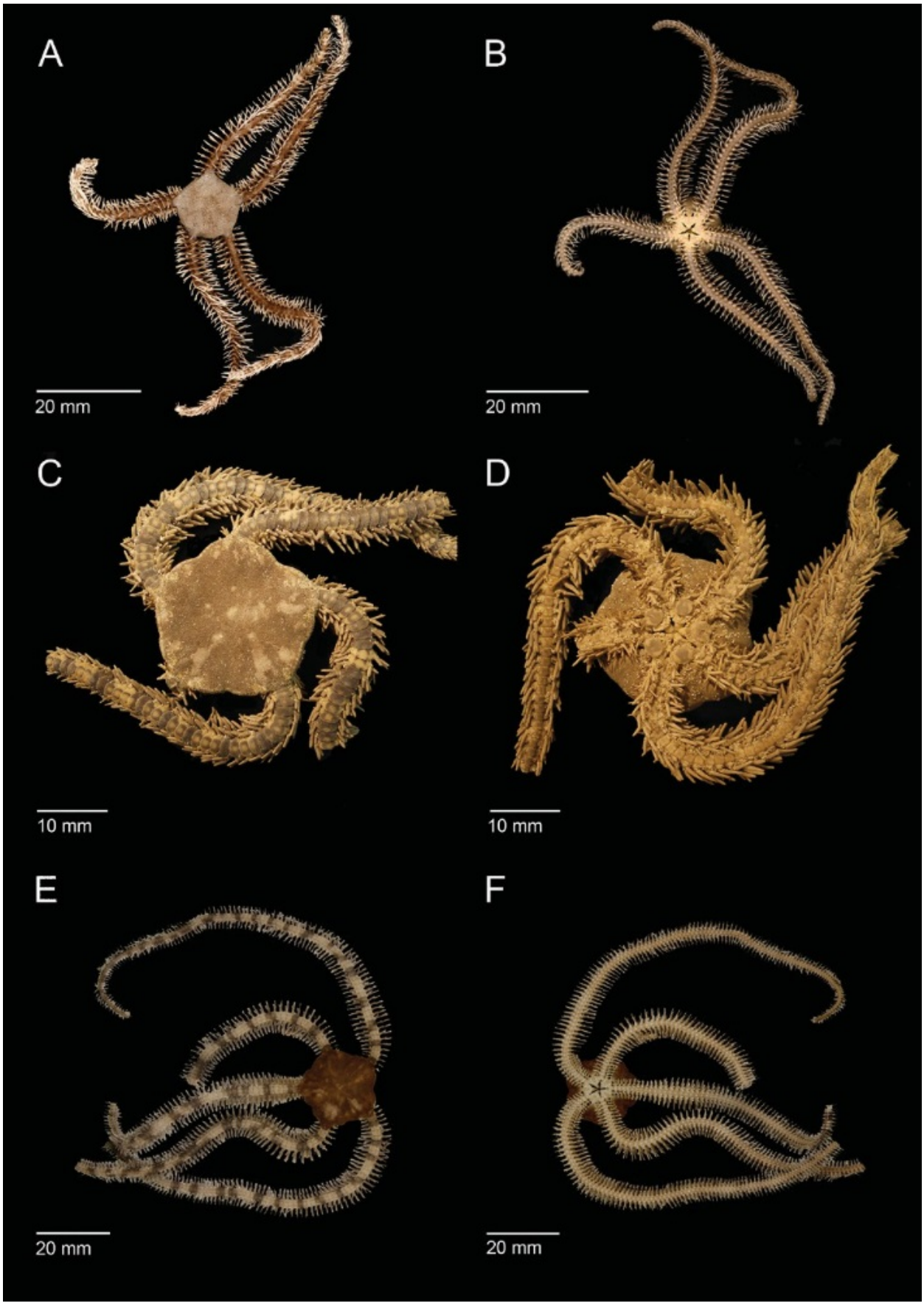

Plate 3.4. Dorsal (A) and ventral (B) views of *Ophiocoma pusilla*; dorsal (C) and ventral (D) views of *Ophiocoma scolopendrina* (neotype MNHN EcOh 11043); dorsal (E) and ventral (F) views of *Ophiocoma valenciae*.

Chapter 4: The rediscovery of a collection of echinoderms, including two holotypes, in the Durban Natural Science Museum, South Africa.

ABSTRACT

This chapter reports on an orphaned collection of echinoderms housed at the Durban Natural Science Museum, South Africa. The collection includes holotypes of the South African endemic ophiuroid *Asteroschema capensis* Mortensen, 1925 [=*Asteromorpha capensis* (Mortensen, 1925) according to Okanishi *et al.*, 2013] and the South African endemic asteroid *Anthenoides marleyi* Mortensen, 1925. The holotype of the asteroid *Hacelia superba* var. *capensis* Mortensen, 1925 has not been found and is considered lost, whilst the holotype of *Anthosticte pacei* Mortensen, 1925 [=*Tethyaster pacei* (Mortensen, 1925)] is reported to be housed in the Zoological Museum Copenhagen, Denmark. The collection includes both wet and dry specimens of extant Asteroidea, Ophiuroidea, Echinoidea and Holothuroidea, with Crinoidea being absent. Holothuroidea were excluded from examinations due to lack of locality data. In addition, *Plococidaris verticillata* (Lamarck, 1816) is a new distribution record for South Africa. This chapter gives new accession numbers of the specimens and the only photographic record of this collection.

INTRODUCTION

In 2011, the National Research Foundation and the South African National Biodiversity Institute commissioned an audit of the national science and zoological collections to assess the state and sustainability of the natural collections within South Africa (Michelle Hamer, pers. comm.). This process noted that echinoderms were part of the Durban Natural Science Museum (DNSM) collection. Among the specimens, the holotypes of the ophiuroid species *Asteroschema capensis* Mortensen, 1925 and the asteroid species *Anthenoides marleyi* Mortensen, 1925 were found preserved dry and in good condition. Some of the specimens had accession numbers, but the catalogue in which these are recorded is unknown and presumed lost (Kirstin Williams, pers. comm.)

The importance of this collection to Mortensen's (1925) paper became immediately apparent, for in it he reported that he had received a small collection of echinoderms from Dr E.C. Chubb, curator of what was then known as the Durban Museum and Art Gallery. The material included specimens of *Dactylosaster cylindricus* (Lamarck, 1816) and *Ophiactis savignyi* (Müller and Troschel, 1842), neither of which can now be found in the DNSM. More importantly, however, Mortensen described three new species, *Asteroschema capensis, Anthenoides marleyi and Anthosticte pacei [=Tethyaster pacei* according to Clark and Clark, 1954] from this collection. The holotypes of the first two of these species are still located in the DNSM collection, but that of *A. pacei* is located in the Zoological Museum, Copenhagen, Denmark[6]. Lastly, Mortensen described a variety of the Atlantic starfish *Hacelia superba* (var. *capensis*) from DNSM material.

Although the remaining echinoderm collection at the DNSM is small, a few additions have been made subsequent to Mortensen's work, but the labels are not consistent in indicating the collector. The collection contains specimens of Asteroidea, Ophiuroidea and Echinoidea. No Crinoidea are included in the collection and, although Holothuroidea were present, no location data were found and these specimens have therefore been excluded from the following account.

[6] http://www.zmuc.dk/InverWeb/invertebrater/Hjemmesider/Asteroidea.htm

Re-discovered species are listed by class, in generic alphabetical order, under the currently accepted names. The collection number, locality data, origin, measurements, number of specimens and mode of preservation are presented in Table 4.1. Photographs of specimens are also presented (Plates 4.1-4.4). The localities referred to for all specimens in this study are shown in Figure 4.1.

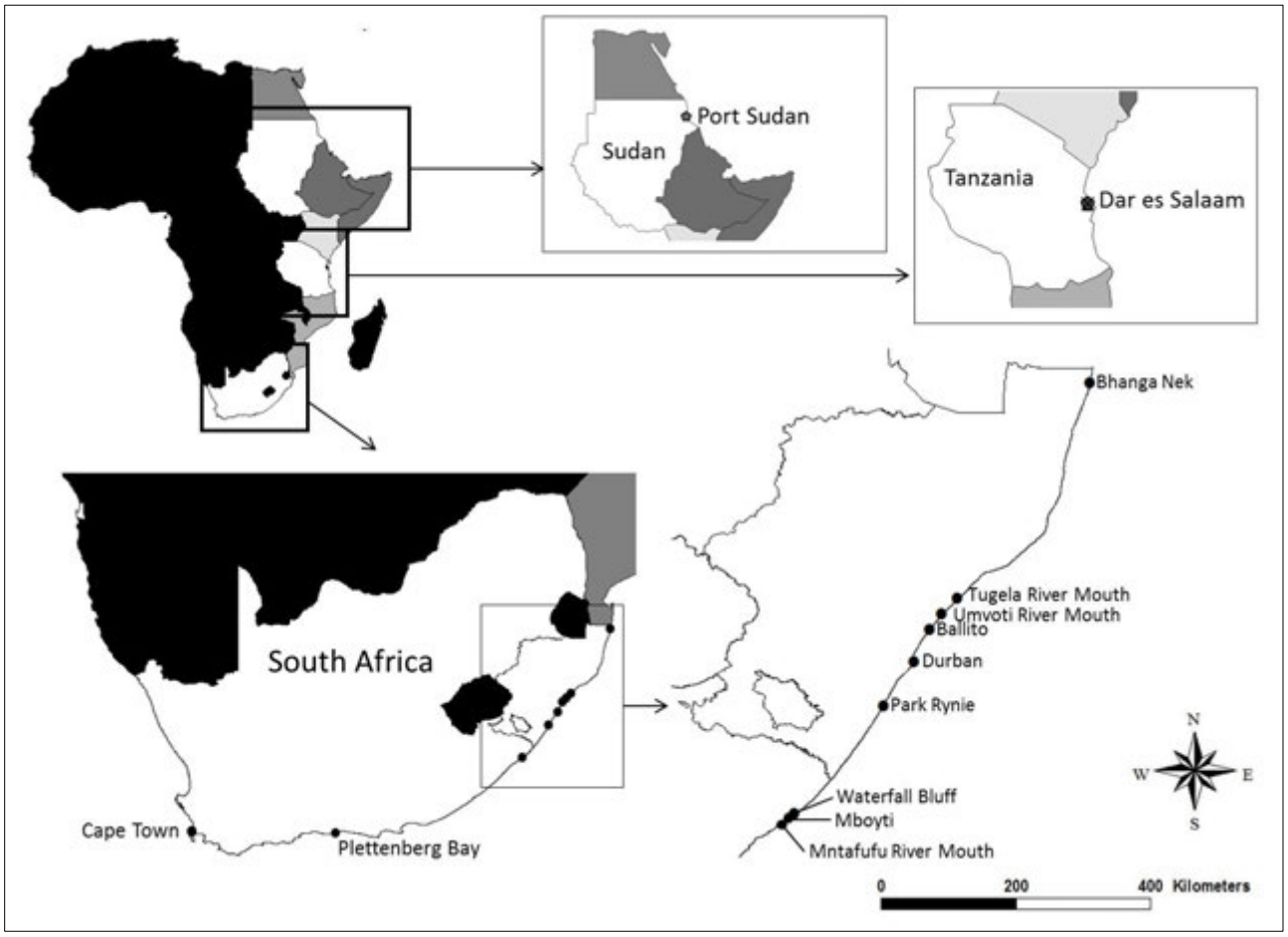

Figure 4.1. Localities referred to during a study on the echinoderm collection of the Durban Natural Science Museum, KwaZulu-Natal, South Africa.

Table 4.1. Summary of the data available for the echinoderm material housed at the Durban Natural Science Museum (DNSM). Measurements used: Ophiuroidea: disc diameter (D.D.); Asteroidea: major radius (R) and minor radius (r); Echinoidea: horizontal diameter (h.d.), vertical diameter (v.d.) and for irregular urchins, length (L), all expressed in millimetres. The preservation method includes dry and wet (in ethanol). Photographic references refer to plate reference numbers.

DNSM Number	Locality	Species	Measurements (mm)	Number of specimens	Plate
Asteroidea					
DNSM ECH 15	Durban	*Astropecten inermis*	R = 27; r = 9	1 (wet)	4.1A
DNSM ECH 28	Umvoti River Mouth	*Anthenoides marleyi*	R = 90; r = 33	1 (dry)	4.1B
DNSM ECH 16	Mntafufu River Mouth	*Parvulastra exigua*	R = 8-11; r = 6-8	6 (wet)	4.1C
DNSM ECH 17	Ballito	*Parvulastra exigua*	R = 5-12; r = 3-8	11 (wet)	4.1C
DNSM ECH 18	Park Rynie	*Parvulastra exigua*	R = 9-13; r = 6-9	5 (wet)	4.1C
DNSM ECH 14	Durban	*Pteraster capensis*	R = 53; r = 39	1 (wet)	4.1D
DNSM ECH 22	Cape Town	*Henricia ornata*	R = 4; r = 1	1 (wet)	4.1E
Ophiuroidea					
DNSM ECH 1	Umvoti River Mouth	*Asteroschema capensis*	D.D. = 8	1 (dry)	4.1F
DNSM ECH 23A	North of Durban	*Ophiothela venusta*	D.D. = 2-6	23 (wet)	4.2A
DNSM ECH 27	Dar es Salaam, Tanzania	*Ophiothrix (Acanthophiothrix) proteus*	D.D. = 15	1 (wet)	4.2B
DNSM ECH 23C	North of Durban	*Ophiothrix* sp. *juv.*	D.D. = 3	1 (wet)	4.2C
DNSM ECH 23D	North of Durban	*Amphioplus (Lymanella) integer*	D.D. = 3	1 (wet)	4.2D
DNSM ECH 23E	North of Durban	*Amphioplus (Lymanella) integer*	D.D. = 3	1 (wet)	4.2E
DNSM ECH 19	Cape Town	*Amphiura capensis*	D.D. = 2	1 (wet)	4.2F
DNSM ECH 20	Cape Town	*Amphiura capensis*	D.D. = 3	1 (wet)	4.2F
DNSM ECH 21A	Cape Town	*Amphiura capensis*	D.D. = 5	1 (wet)	4.2F
DNSM ECH 21B	Cape Town	*Ophiactis carnea*	D.D. = 6	1 (wet)	4.3A
DNSM ECH 24	North of Durban	*Ophiactis carnea*	D.D. = 1-2	2 (wet)	4.3A
DNSM ECH 25	Tugela River Mouth	*Ophiactis carnea*	D.D. = 4	1 (wet)	4.3A
DNSM ECH 23B	North of Durban	*Ophiactis plana*	D.D. = 2	1 (wet)	4.3B
DNSM ECH 26	Waterfall Bluff	*Ophiomitrella hamata*	D.D. = 5	1 (wet)	4.3C
DNSM ECH 3	Mbotyi	*Ophiarachnella capensis*	D.D. = 19	1 (dry)	4.3D
Echinoidea					
DNSM ECH 4	Durban Harbour	*Plococidaris verticillata*	h.d. = 32; v.d. = 22	1 (dry)	4.3E
DNSM ECH 9	Bhanga Nek	*Stomopneustes variolaris*	h.d. = 52-115; v.d. = 15-35	2 (wet)	4.3F
DNSM ECH 11	Durban	*Salmacis bicolor*	h.d. = 32; v.d. = 56	1 (wet)	4.4A
DNSM ECH 7	Durban	*Tripneustes gratilla*	h.d. = 46-82; v.d. = 23-56	2 (wet)	4.4B
DNSM ECH 8	Durban	*Tripneustes gratilla*	h.d. = 64-68; v.d. = 37-38	2 (wet)	4.4B
DNSM ECH 13	Port Sudan, Sudan	*Tripneustes gratilla*	h.d. = 41; v.d. = 61	1 (wet)	4.4B
DNSM ECH 12	Cape Town	*Parechinus angulosus*	h.d. = 3-9; v.d. = 4-16	5 (wet)	4.4C
DNSM ECH 10	Bhanga Nek	*Echinostrephus molaris*	h.d. = 13; v.d. = 19	1 (wet)	4.4D
DNSM ECH 5	Durban Harbour	*Clypeaster eurychorius*	L = 95	1 (dry)	4.4E
DNSM ECH 2	Plettenberg Bay	*Echinodiscus bisperforatus*	L = 43-52	2 (dry)	4.4F

TAXONOMC ACCOUNT

Phylum ECHINODERMATA Bruguiere, 1791 (Ex Klein, 1734)
Class ASTEROIDEA De Blainville, 1830

Five species were recovered.

Order PAXILLOSIDA Perrier, 1884
Family ASTROPECTINIDAE Gray, 1840

Genus *Astropecten* Gray, 1840

***Astropecten inermis* (De Loriol, 1899)**
(Plate 4.1A)

Astropecten inermis: De Loriol, 1899: 14-16, pl. 2, fig. 2a-g; Jangoux, 1985: 23; Clark, 1989: 260.
Astropecten cingulatus Sladen, 1883: 266, 267.
Astropecten antares Döderlein, 1926: 6; Clark and Rowe, 1971: 30-31 (distribution table), 40 (note 1), 46 (key); Clark and Courtman-Stock, 1976: 23 (distribution table), 32 (key), 48 (text); Clark, 1989: 251.

Material: 1 specimen (DNSM ECH15), Durban.
Distribution: Cape of Good Hope to Mozambique; depth range 6-64m (Clark and Rowe, 1971; Clark, 1989).
Remarks: Clark (1989: 251-252; 260) supports Jangoux's (1985) resurrection of the species *Astropecten inermis,* (an Indian Ocean species), from its synonymy with the Atlantic species *A. cingulatus*, and the synonymy of *A. antares* with *A. inermis*. However, Clark (1989) believed a case could be put to the ICZN for the suppression of *A. inermis* in favour of *A. antares,* the former species having been included in the synonymy of *cingulatus,* as placed by Döderlein (1917), thus raising the status of *antares* as used in Clark and Rowe (1971). The original label indicates that the specimen was collected from the 'coast off Durban' by 'A. Wright'.

Order VALVATIDA Perrier, 1884
Family GONIASTERIDAE Forbes, 1841

Genus *Anthenoides* Perrier, 1881

***Anthenoides marleyi* Mortensen, 1925**
(Plate 4.1B)

Anthenoides marleyi Mortensen, 1925: 149-151, pl. 8, figs 2-4; Mortensen, 1933c: 15 (distribution table), 245 (text); Clark and Courtman-Stock, 1976: 25 (distribution table), 36 (fig. 59), 37 (key), 60 (text); Clark, 1993: 242.

Material: Holotype (DNSM ECH 28); off Umvoti River mouth, KwaZulu-Natal, 35-40 fathoms (64-73m).
Distribution: KwaZulu-Natal, Zanzibar Channel; depth range 64-274m (Clark, 1993).

Family ASTERINIDAE Gray, 1840

Genus *Parvulastra* O'Loughlin and Waters, 2004

Parvulastra exigua (Lamarck, 1816)

(Plate 4.1C)

Asterias exigua Lamarck, 1816: 554.
Patiriella exigua: Clark and Courtman-Stock, 1976: 27 (distribution table), 40 (key), 81 (text); Clark and Downey, 1992: 192, figs 31h, 32l, pl. 40E, F; Clark, 1993: 225.
Parvulastra exigua: O'Loughlin and Waters, 2004: 27, figs 1 (clade V), 2l, 11b, 16a-d; Branch *et al.*, 2010: 224, pl. 100.5.

Material: 6 specimens (DNSM ECH16), Mntafufu River mouth; 11 specimens (DNSM ECH17), Ballito; 5 specimens (DNSM ECH18), Park Rynie.
Distribution: South Africa, from Mozambique west to Namibia; St Helena, Amsterdam and St Paul Islands, South Indian Ocean and southern Australia; depth range 0-10m (Clark, 1993).
Remarks: Lamarck (1816) described this species from specimens from 'Les mers d'Amerique'. Since then much confusion and debate has taken place regarding the taxonomy of this species and in order to stabilise the taxonomy of this species, and in the absence of name-bearing type specimens, Dartnall (1971) selected a neotype from False Bay, South Africa. In a wide ranging morphological and molecular study of the family Asterinidae, O'Loughlin and Waters (2004) described several new genera, including *Parvulastra* O'Loughlin in O'Loughlin and Waters (2004), in which they designated *P. exigua* as the type species. The original label indicates that the specimens DNSM ECH 16 and DNSM ECH 17 were collected by W.J. Lawson and DNSM ECH 18 was collected on 15 April 1914 by H.W Bell Marley.

Order VELATIDA Perrier, 1884
Family PTERASTERIDAE Perrier, 1875

Genus *Pteraster* Müller and Troschel, 1842

Pteraster capensis Gray, 1847

(Plate 4.1D)

Pteraster capensis Gray, 1847: 83; Clark and Courtman-Stock, 1976: 28 (distribution table), 38 (key), 84-85 (text); Clark and Downey, 1992: 327, pl. 79l, J; Clark, 1996: 207; Branch *et al.*, 2010: 224, pl. 100.3

Material: 1 specimen (DNSM ECH14), off Durban.
Distribution: Luderitz Bay, Namibia to Durban, KwaZulu-Natal; depth range 34-370m (Clark, 1996).
Remarks: Specimen is well preserved, but with signs of deterioration. The original label indicates that the specimen DNSM ECH 14 was collected by the trawler *John Meikle*, by A. Wright.

Order SPINULOSIDA Perrier, 1884
Family ECHINASTERIDAE Verrill, 1870

Genus *Henricia* Gray, 1840

Henricia ornata (Perrier, 1869)

(Plate 4.1E)

Echinaster (Cribella) ornatus Perrier, 1869: 59.
Henricia ornata: Clark and Courtman-Stock, 1976: 28 (distribution table), 42 (key), 89-90 (text); Clark and Downey, 1992: 394, fig. 60U, pl. 95D, E; Clark, 1996: 237; Branch *et al.*, 2010: 226, pl. 101.4

Material: 1 specimen (DNSM ECH22), Cape Town.
Distribution: Luderitz Bay to East London; depth range 0-90m (Clark, 1996).
Remarks: Specimen is in good condition. The original label indicates the specimen DNSM ECH 22 was collected in 1964.

Class OPHIUROIDEA Gray, 1840

A total of 38 specimens representing 10 species from six families were found in the collection. All specimens are preserved in ethanol, except two, labelled as *Asteroschema capensis* Mortensen, 1925 [=*Asteromorpha capensis* (Mortensen, 1925)] and *Ophiarachnella capensis* (Bell, 1888).

Order EURYALIDA Lamarck, 1816
Family EURYALIDAE Gray, 1840

Genus *Asteroschema* Oersted and Lütken, 1856

Asteroschema capensis (Mortensen, 1925)

(Plate 4.1F)

Astroschema capensis Mortensen, 1925: 152-154, pl. 8, figs 4, 5, fig. 5; Mortensen, 1933c: 221, 227;
Asteroschema capensis: Clark and Courtman-Stock, 1976: 100 (distribution table), 108 (key), 130 (text), fig. 95; Sink *et al.*, 2006: 469-470.
Asteroschema capense: Okanishi and Fujita, 2009: 116, 119, 123, 125; Okanishi and Fujita, 2011:149.
Asteromorpha capensis Okanishi *et al.,* 2013: 462-467, figs 2-5.

Material: Holotype, (DNSM ECH 1), off Umvoti River mouth, KwaZulu-Natal, 35-40 fathoms (64-73m).
Distribution: South Africa; depth range 64-132m (Clark and Courtman-Stock, 1976).
Remarks: Specimen in good condition. Clark and Courtman-Stock (1976) recorded that the specimen had no depth information; however, the label on the specimen gives the depth as 35-40 fathoms.

Order OPHIURIDA Müller and Troschel, 1840
Family OPHIOTRICHIDAE Ljungman, 1867

Genus *Ophiothela* Verrill, 1867

Ophiothela venusta (De Loriol, 1900)

(Plate 4.2A)

Ophiocnemis venusta De Loriol, 1900: 81, pl. 8, figs 2, 3.
Ophiothela venusta: Clark and Rowe, 1971: 84-84 (distribution), 117 (key), pl.14, fig. 16; Cherbonnier and Guille, 1978: 160-164, fig. 62; Lane *et al.*, 2000: 481.

Ophiopsammium nudum: Clark, 1923: 341.
Ophiothela nuda: Clark, 1974: 469; Clark and Courtman-Stock, 1976: 101 (distribution table), 114 (key), 141 (text), fig. 120.

Material: 23 specimens (DNSM ECH 23A), north of Durban.
Distribution: Western Indian Ocean to north west Australia and South China Sea; depth range 0-80m (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Rowe and Gates, 1995; Lane *et al.*, 2000).
Remarks: Most of these specimens are in fair condition.

Genus *Ophiothrix* Müller and Troschel, 1840

Ophiothrix (Acanthophiothrix) proteus Koehler 1905
(Plate 4.2B)

Ophiothrix proteus Koehler, 1905a: 100; Koehler, 1922b: 260-261, pl. 36, fig. 3, 4, pl. 101, fig. 3.
Ophiothrix (Acanthophiothrix) proteus: Clark, 1966: 648; Clark and Rowe, 1971: 84, 85 (distribution table), 111 (key), pl.15, fig. 5; Clark, 1974: 465, fig. 11a, b: Clark and Courtman-Stock, 1976: 101 (distribution table), 112 (key), 142 (text), fig. 110; Cherbonnier and Guille, 1978: 147-148; pl. 6, figs 3, 4; Liao and Clark, 1995: 240; Rowe and Gates, 1995: 424; Lane *et al.*, 2000: 481.

Material: 1 specimen (DNSM ECH 27), Dar es Salaam, Tanzania.
Distribution: Red Sea, Western Indian Ocean to Great Barrier Reef, north to Philippines and South China Sea to Marshall Islands and New Caledonia; depth range 0-125m (Clark and Rowe, 1971; Guille and Vadon, 1986; Rowe and Gates, 1995; Lane *et al.*, 2000).
Remarks: This specimen is in bad condition and missing whole arms. The original label indicates the specimen DNSM ECH 27 was collected between 28 & 31 January 1963, the depth on the label was not legible.

Ophiothrix sp. juv.
(Plate 4.2C)

Material: 1 specimen (DNSM ECH 23C), north of Durban.
Remarks: In fair condition, numerous spines missing.

Family AMPHIURIDAE Ljungman, 1867

Genus *Amphioplus (Lymanella)* Clark, 1970

Amphioplus (Lymanella) cf. *integer* (Ljungman, 1867)
(Plate 4.2D, 4.2E)

Amphipholis integra Ljungman, 1867a: 313.
Amphioplus integer: Clark, 1923: 330-331; Mortensen, 1933c: 368-370, figs 73, 74;
Amphioplus (Lymanella) integer: Clark and Rowe, 1971: 80, 81 (distribution table), 102-103 (key); Clark, 1974: 453-455; Clark and Courtman-Stock, 1976: 102 (distribution table), 117 (key), 149 (text), figs 123, 137, 150; Sloan *et al.*, 1979: 101; Richmond, 2002: 326.

Material: 2 specimens (DNSM ECH 23D and 23E); North of Durban.

Distribution: Western Indian Ocean including the Red Sea (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Sloan *et al.*, 1979); depth range 0-62m (Clark and Courtman-Stock, 1976).
Remarks: DNSM 23E is not in good condition, disc broken and is identified as this species with reservation.

Genus *Amphiura (Amphiura)* Forbes, 1843

Amphiura (Amphiura) cf. *capensis* Ljungman, 1867
(Plate 4.2F)

Amphiura (*Amphiura*) *capensis* Ljungman, 1867a: 320; Clark, 1923: 327; Mortensen, 1933c: 348-350; Clark, 1974: 445-447; Clark and Courtman-Stock, 1976: 103 (distribution table), 117 (key), 155 (text), fig. 143; Branch *et al.*, 2010: 232, pl. 104.3.

Material: 3 specimens (DNSM ECH 19; DNSM ECH 20; DNSM ECH 21A), Cape Town.
Distribution: Southern Africa, Durban to Maputo, depth range 0-180m (Clark and Courtman-Stock, 1976).
Remarks: DNSM ECH 19 & DNSM ECH 20 are damaged and are identified as this species with reservation. The original label indicates that the specimens DNSM ECH 19, DNSM ECH 20 and DNSM ECH 21A were collected in 1964.

Family OPHIACTIDAE Matsumoto, 1915

Genus *Ophiactis* Lütken, 1856

Ophiactis carnea Ljungman, 1867
(Plate 4.3A)

Ophiactis carnea Ljungman, 1867a: 324-325; Clark, 1923: 332-333, pl. 20, figs 3, 4; Mortensen, 1933c: 342-345, figs 54-56; Clark, A.M., 1952: 199 (table); Clark and Courtman-Stock, 1976: 104 (distribution table), 119 (key), 161-162 (text), figs 159, 166; Branch *et al.*, 2010: 232, pl. 104.6.

Material: 1 specimen (DNSM ECH 21B), Cape Town; 2 specimens (DNSM ECH 24), North of Durban; 1 specimen (DNSM ECH 25), 18 miles East off Tugela River mouth.
Distribution: Southern Africa, Cape Town to Maputo (Clark and Courtman-Stock, 1976), Western Indian Ocean, (Clark and Rowe, 1971), depth range 0-220m (Clark and Courtman-Stock, 1976).
Remarks: These specimens are in fair condition, although some arms are missing. The original label indicates that the specimen DNSM ECH 21B was collected in 1964, while DNSM ECH 25 was collected in May 1921 by the Trawler *John Meikle*.

Ophiactis plana Lyman, 1869
(Plate 4.3B)

Ophiactis plana Lyman, 1869: 311 (table), 330-331; Clark, 1923: 333; Mortensen, 1933c: 345-346, fig. 57, Clark, 1974: 464-465; Clark and Courtman-Stock, 1976: 104 (distribution table), 119 (key), 163-164 (text), figs 157, 164.

Material: 1 specimen (DNSM ECH 23B), north of Durban.

Distribution: Southern Africa, Cape Town to Maputo and the Gulf of Mexico, depth range 0-238m (Clark and Courtman-Stock, 1976).
Remarks: Type locality is the Florida Strait, depth 200m. The original label indicates that the specimen DNSM ECH 23B was collected by W.J. Lawson and M.J. Woods in 1964.

Family OPHIACANTHIDAE Ljungman, 1867

Genus *Ophiomitrella* Verrill, 1899

***Ophiomitrella* cf. *hamata* Mortensen, 1933**
(Plate 4.3C)

Ophiomitrella hamata Mortensen, 1933c: 333-335, figs 50, 51, pl. 19, fig. 12; Clark and Courtman-Stock, 1976: 105 (distribution table), 121 (key), 170 (text), fig. 178.

Material: 1 specimen (DNSM ECH 26), Waterfall Bluff, Eastern Cape, 35-50 fathoms (64-91m).
Distribution: South Africa, off Durban, 412m (Clark and Courtman-Stock, 1976).
Remarks: The single specimen is attached to a gorgonian. It shows one, perhaps two, disc spines on each disc scale; radial shields are well in contact as opposed to just touching. Due to the morphology, it is with hesitation that this specimen is identified as *O. hamata* without more comparative material at hand.

The original label indicates that the specimen DNSM ECH 26 was collected by Captain Page in April 1921.

Family OPHIODERMATIDAE Ljungman, 1867

Genus *Ophiarachnella* Ljungman, 1872

***Ophiarachnella capensis* (Bell, 1888)**
(Plate 4.3D)

Pectinura capensis Bell, 1888: 282, pl. 16, figs 3, 4.
Ophiarachnella capensis: Clark, 1923: 351 (text); Mortensen, 1933c: 380-381, fig. 82; Clark and Courtman-Stock, 1976: 106 (distribution table), 124 (key), 182-183 (text), fig. 205; Branch *et al.*, 2010: 230, pl.103.2.

Material: 1 specimen, (DNSM ECH 3), Mbotyi, Eastern Cape.
Distribution: South Africa, Cape Town to Durban; Vema Seamount; depth range 0-91m (Clark and Courtman-Stock, 1976).
Remarks: This specimen is in fair condition, the ventral side is well preserved, while the dorsal side shows evidence of deterioration.

Class ECHINOIDEA Leske, 1778
Order CIDAROIDA Claus, 1880

A total of eight species (17 specimens), representing eight families were found in the collection. Three species (*Echinodiscus bisperforatus, Plococidaris verticillata, Clypeaster eurychorius*) are preserved dry and in good condition. The remaining echinoids are in fair-good condition and preserved in ethanol.

Family CIDARIDAE Gray, 1825

Genus *Plococidaris* Mortensen, 1909

***Plococidaris verticillata* (Lamarck, 1816)**
(Plate 4.3E)

Cidaris verticillata Lamarck, 1816: 531(10th ed).
Plococidaris verticillata: Mortensen, 1928: 428-433, figs 131-133, pl. 51, figs 3-7, pl. 74, fig. 5, pl. 83, figs 19-21.
Prionocidaris verticillata: Clark, 1946: 287; Clark and Rowe, 1971: 140-141 (distribution table), 151 (key), fig. 61; Rowe and Gates, 1995: 199; Samyn, 2003: 200-201, fig. 2E, E'; Lane *et al.*, 2000: 484; Richmond, 2002: 304, 305.

Material: 1 specimen (DNSM ECH 4), Durban Harbour.
Distribution: Indo-West Pacific; depth range 0-54m (Clark and Rowe, 1971; Rowe and Gates, 1995; Lane *et al.*, 2000; Richmond, 2002).
Remarks: This is a new record for this widespread species, extending its distribution south along the east African coast from Kenya (Samyn, 2003). Both Clark (1946) and Hoggett and Rowe (1986) synonymised *Plococidaris* with *Prionocidaris* despite the different spine morphology (Kroh and Mooi, 2013).

Order STOMOPNEUSTOIDA Kroh and Smith, 2010
Family STOMOPNEUSTIDAE Mortensen, 1903

Genus *Stomopneustes* Agassiz, 1841

***Stomopneustes variolaris* (Lamarck, 1816)**
(Plate 4.3F)

Echinus variolaris Lamarck, 1816: 525 (10th ed).
Stomopneustes variolaris: Clark, 1923: 378; Mortensen, 1935: 507-512, figs 301, 302, pl. 71, figs 3-5, pl. 72, figs 1-2; Clark and Rowe, 1971: 140-141 (distribution table), 153 (key), fig. 65a; Rowe and Gates, 1995: 246; Samyn, 2003: 208, fig. 4A; Clark and Courtman-Stock, 1976: 228 (text), 201 (distribution table), 209 (key), fig. 240; Lane *et al.*, 2000: 484; Branch *et al.*, 2010: 234, pl. 105.3; Richmond, 2002: 306, 307.

Material: 2 specimens (DNSM ECH 9), Bhanga Nek, South Africa.
Distribution: South Africa, Durban to Maputo and across the tropical Indo-West Pacific (except Hawaii); depth range 0-30m (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Lane *et al.*, 2000; Richmond, 2002; Samyn, 2003; Branch *et al.*, 2010).
Remarks: This specimen is not very well preserved. The original label indicates that the specimen DNSM ECH 9 was collected in December 1964.

Order CAMARODONTA Jackson, 1912
Family TEMNOPLEURIDAE Agassiz, 1872

Genus *Salmacis* Agassiz, 1841

Salmacis bicolor L. Agassiz [in] Agassiz and Desor, 1846

(Plate 4.4A)

Salmacis bicolor L. Agassiz [in] Agassiz and Desor, 1846: 359, pl. 15, fig. 4; Clark, 1923: 382; Clark, 1924: 5; Mortensen, 1943a: 112-117, figs 67a, 68a, pl. 4, figs 1-8, pl. 5, figs 1-3, 10-12, pl. 6, figs 1-8, pl. 46, figs 1, 13, 16, 19, 20; Clark, A.M., 1952: 201; Clark and Rowe, 1971: 140-141 (distribution), 156 (key); Clark and Courtman-Stock, 1976: 202 (distribution), 209 (key), 232 (text); Samyn, 2003: 209, fig. 4C; Lane *et al.*, 2000: 485; Branch *et al.*, 2010: 234, pl. 105.4; Richmond, 2002: 306, 307.

Material: 1 specimen (DNSM ECH 11), Durban, South Africa.
Distribution: South Africa, Durban to Maputo, and throughout the tropical Indo-West Pacific; depth range 0-69m (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Lane *et al.*, 2000; Branch *et al.*, 2010; Richmond, 2002).
Remarks: This specimen is in good condition and the colours have been well preserved. The original label indicates that the specimen DNSM ECH 11 was collected by P. Elston.

Family TOXOPNEUSTIDAE Troschel, 1872

Genus *Tripneustes* Linnaeus, 1758

Tripneustes gratilla (Linnaeus, 1758)

(Plate 4.4B)

Echinus gratilla Linnaeus, 1758: 664.
Tripneustes gratilla: Clark, 1923: 387; 1946: 326; Mortensen, 1943a: 500-508, figs 306, 307, pl. 33, figs 1-3, pl. 34, figs 2-6, pl. 35, figs 3-4, pl. 37, figs 1-2, 4-10; pl. 38, figs 1-4; Clark and Rowe, 1971: 141-142 (distribution), 156 (key), fig. 65b; Clark and Courtman-Stock, 1976: 234 (text), 202 (distribution table), 211 (key), fig. 256; Rowe and Gates, 1995: 259; Samyn, 2003: 210-211, fig. 4G; Lane *et al.*, 2000: 485; Branch *et al.*, 2010: 234, pl. 105.5; Richmond, 2002: 308, 309.

Material: 2 specimens (DNSM ECH 7), Durban, South Africa; 2 specimens (DNSM ECH 8); Durban, South Africa and 1 specimen (DNSM ECH 13), Port Sudan, Sudan.
Distribution: South Africa, Port Elizabeth to Maputo, and throughout the tropical Indo-West Pacific; depth range 0-15m (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Rowe and Gates, 1995; Lane *et al.*, 2000).
Remarks: These specimens are preserved wet. The original label indicates that the specimen DNSM ECH 13 was collected in January 1958.

Family PARECHINIDAE Mortensen, 1903

Genus *Parechinus* Mortensen, 1903

Parechinus angulosus (Leske, 1778)

(Plate 4.4C)

Cidaris angulosa var. *minor* Leske, 1778: 30, pl. 3, figs A, B.
Parechinus angulosus: Clark, 1923: 385-386; Mortensen, 1943b: 148-156, figs 64-68, pl. 18, figs 8-19, 22, pl. 58, figs 20, 21, 26-32; Clark, A.M., 1952: 201; Clark and Courtman-Stock, 1976: 202 (distribution table), 211 (key), 237-238 (text), fig. 259; Branch *et al.*, 2010: 234, pl. 105.6.

Material: 5 specimens (DNSM ECH 12), Cape Town, South Africa.

Distribution: South Africa, Luderitz Bay to Durban; depth range 0-98m (Clark and Courtman-Stock, 1976).
Remarks: The specimens are of a variety of colours, with sizes ranging from 3-9mm in horizontal diameter. This species is endemic to South Africa. The original label indicates that the specimen DNSM ECH 12 was collected in December 1964.

Family ECHINOMETRIDAE Gray, 1855

Genus *Echinostrephus* Agassiz, 1863

***Echinostrephus molaris* (De Blainville, 1825)**
(Plate 4.4D)

Echinus molaris De Blainville, 1825: 88.
Echinostrephus molare: Clark, 1923: 387-388.
Echinostrephus molaris: Mortensen, 1943b: 311-316, figs 149, 150a, b, pl. 35, figs 1-10, pl. 58, figs 1, 2, 4, 9; Clark and Rowe, 1971: 142-143 (distribution), 157 (key); Clark and Courtman-Stock, 1976: 203 (distribution), 211 (key), 239 (text); Rowe and Gates, 1995: 212; Lane *et al.*, 2000: 486; Richmond, 2002: 308; Samyn, 2003: 205-207, fig. 3F; Branch *et al.*, 2010: 236, fig. 106.2.

Material: 1 specimen (DNSM ECH 10), Durban Harbour, South Africa.
Distribution: South Africa, Durban and throughout the tropical Indo-West Pacific region; depth range, 0-50m (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Rowe and Gates, 1995; Lane *et al.*, 2000; Richmond, 2002).

Remarks: This specimen is in poor condition.

Order CLYPEASTEROIDA Agassiz, 1872
Family CLYPEASTERIDAE Agassiz, 1835

Genus *Clypeaster* Lamarck, 1801

***Clypeaster eurychorius* Clark, 1924**
(Plate 4.4E)

Clypeaster eurychorius Clark, 1924: 10-11, pl. 3; Mortensen, 1948b: 5; Clark and Courtman-Stock, 1976: 203 (distribution table), 213 (key), 241 (text), fig. 265.
Clypeaster (Stolonoclypus) eurychorius: Mortensen, 1948a: 94-96, figs 54, 55, pl. 30, fig. 2, pl. 31, figs 2, 3, pl. 32, fig. 3, pl. 33, fig. 2.

Material: 1 specimen (DNSM ECH 5), Durban Harbour.
Distribution: KwaZulu-Natal, South Africa, Tanzania (Clark and Courtman-Stock, 1976); depth range 166-384m (Clark and Courtman-Stock, 1976).
Remarks: This specimen is denuded of all spines and comprises only a test. A rare and deep-water species, known only from off Durban, its collection in Durban Harbour suggests it has drifted inshore post-mortem.

Family ASTRICLYPEIDAE Stefanini, 1912

Genus *Echinodiscus* Leske, 1778

***Echinodiscus bisperforatus* Leske, 1778**
(Plate 4.4F)

Echinodiscus bisperforatus Leske, 1778: 132; Clark, 1923: 394-395; Mortensen, 1948a: 406-411, figs 241a, 242a, b, pl. 58, figs 2, 6-8, pl. 71, figs 6-9, 18; Clark, A.M., 1952: 202; Clark and Courtman-Stock, 1976: 203 (distribution table), 211 (key), 243 (text), fig. 264; Clark and Rowe, 1971: 144-145 (distribution table), 162 (key), fig. 78; Guille *et al.*, 1986: 46-47 (as *E. bisperforatus trucatus*: Agassiz, 1841); Branch *et al.*, 2010: 236, pl. 106.8; Richmond, 2002: 310, 311.

Material: 2 specimens, DNSM ECH 2, Plettenberg Bay.
Distribution: Red Sea south to Mossel Bay, Cape Province, South Africa, and east to Indo-Malay region and South China Sea: depth range 0-20m (Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Guille *et al.*, 1986; Lane *et al.*, 2000; Branch *et al.*, 2010; Richmond, 2002: 310, 311).
Remarks: This specimen is in good condition.

DISCUSSION

The echinoderm collection of the DNSM does not appear to have been examined by a specialist since Mortensen (1925). However, additional unidentified specimens have been added. These have been collected, on an *ad hoc* basis by naturalists and members of the public, who presumably wanted to donate their specimens to a museum. *Hacelia superba* (var. *capensis*) described by Mortensen is recorded from DNSM material, but the specimen/s were not found. The catalogue in which this collection was recorded could not be located and may be lost. Both wet and dry specimens appear to be in reasonable condition. As a result of this study, the specimens have now been identified, accessioned and a photographic record of all echinoderm specimens housed at DNSM is now available.

ACKNOWLEDGMENTS

The authors are indebted to Mariana Tomalin for discovering the echinoderm collection that had been lost for almost two decades. Dr Kirstin Williams at DNSM is acknowledged for her assistance in arranging examinations. Dr Didier VandenSpiegel of the Royal Museum for Central Africa in Tervuren (Belgium) is thanked for providing logistical and scientific assistance in the identification of this collection. Financial support for this study was provided through a grant to C.L. Griffiths through the National Research Foundation SEAChange Programme and the Belgian National Focal Point to the Global Taxonomic Initiative. Mark O'Loughlin is thanked for his useful suggestions and comments on this chapter.

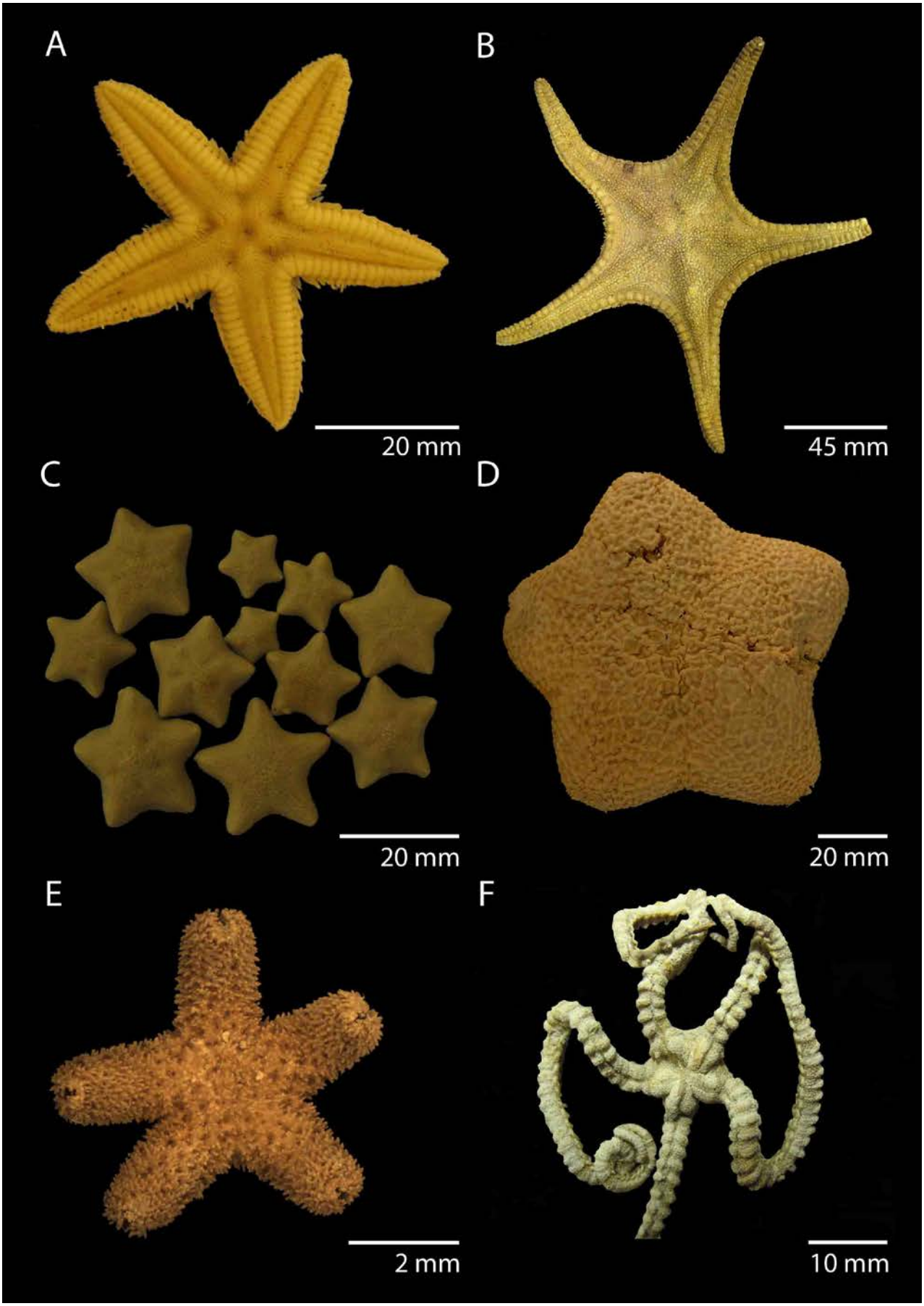

Plate 4.1. Dorsal views of A. *Astropecten inermis;* B. *Anthenoides marleyi;* C. *Parvulastra exigua;* D. *Pteraster capensis;* E. *Henricia ornata;* F. *Asteroschema capensis (=Asteromorpha capensis).*

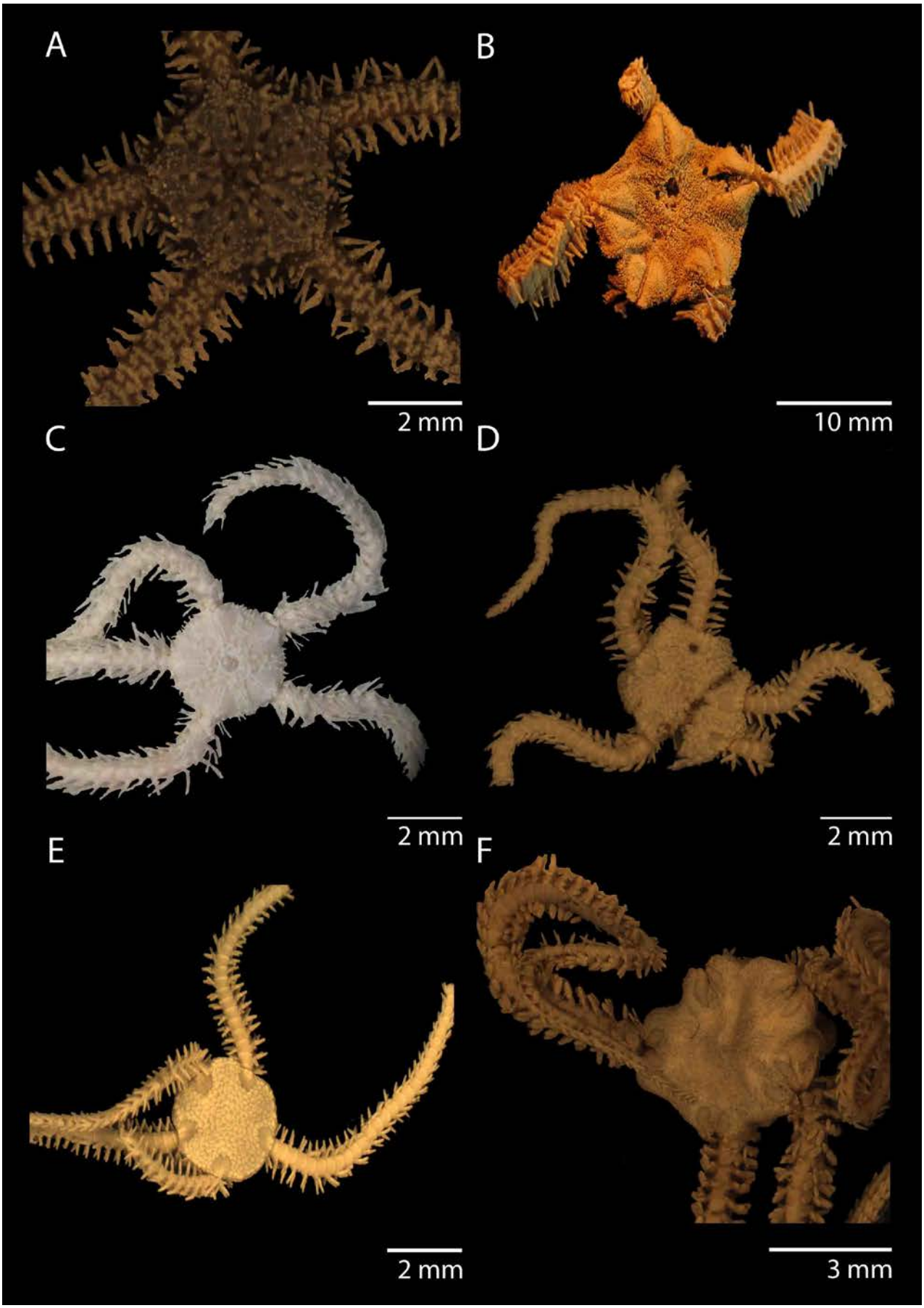

Plate 4.2. Dorsal views of A. *Ophiothela venusta;* B. *Ophiothrix* (*Acanthophiothrix*) *proteus;* C. *Ophiothrix* sp. juv.; D. *Amphioplus (Lymanella) integer*; E. *Amphioplus (Lymanella) integer;* F. *Amphiura (Amphiura) capensis.*

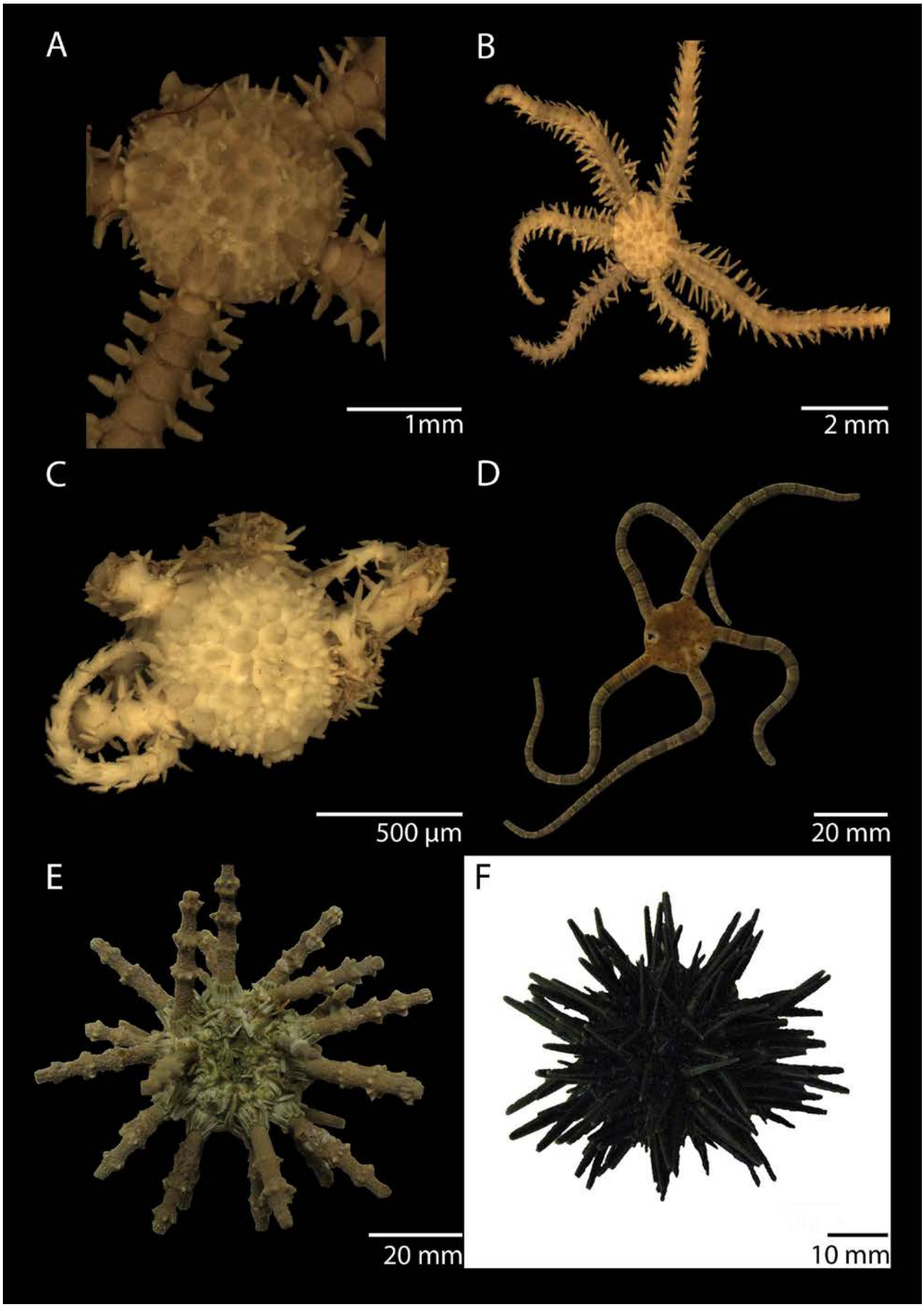

Plate 4.3. Dorsal views of A. *Ophiactis carnea;* B. *Ophiactis plana;* C. *Ophiomitrella hamata;* D. *Ophiarachnella capensis;* E. *Plococidaris verticillata;* F. *Stomopneustes variolaris.*

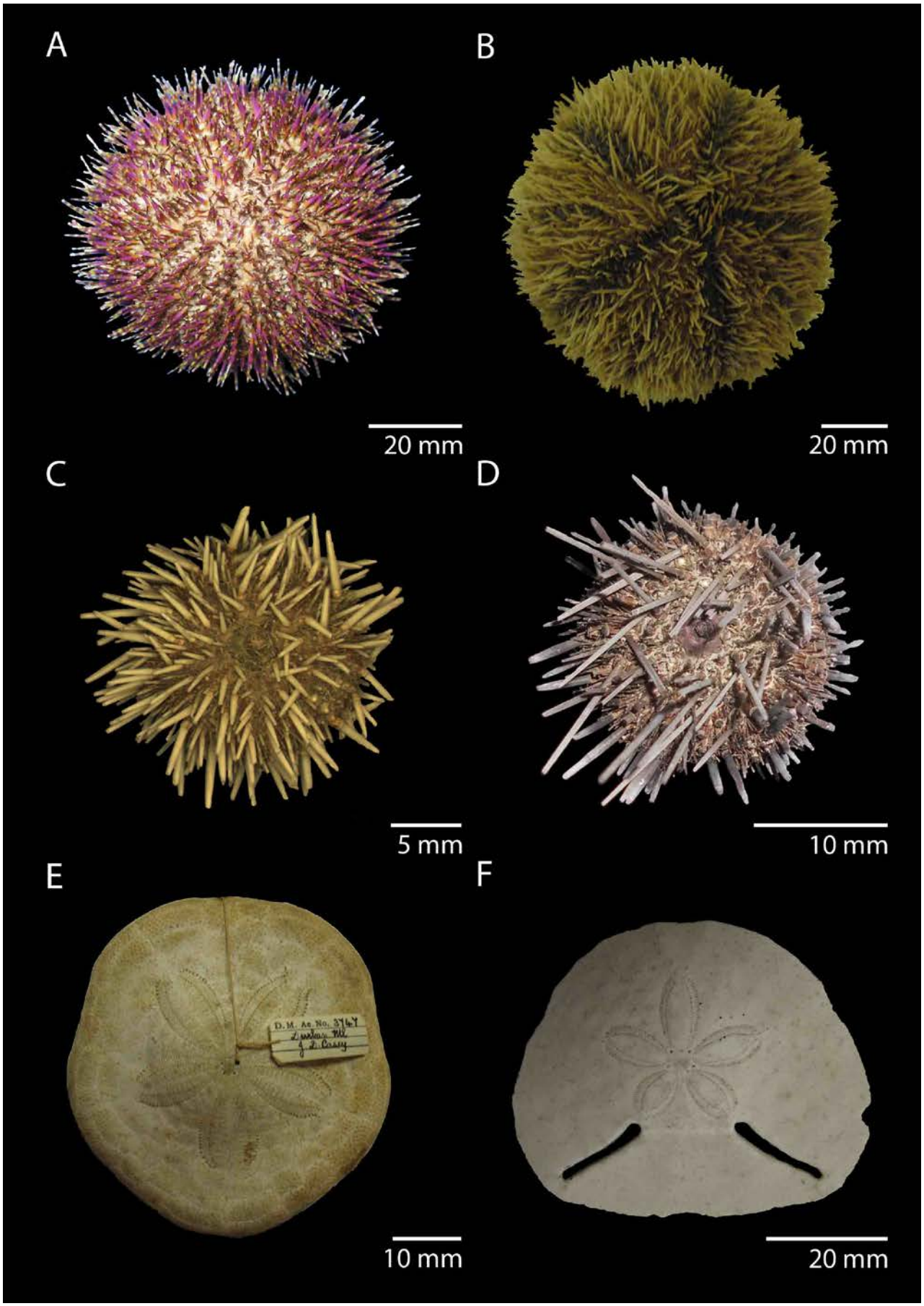

Plate 4.4. Dorsal views of A. *Salmacis bicolor;* B. *Tripneustes gratilla;* C. *Parechinus angulosus;* D. *Echinostrephus molaris;* E. *Clypeaster eurychorius;* F. *Echinodiscus bisperforatus.*

Chapter 5: A taxonomic review of the genus *Asteromorpha* Lütken (Echinodermata: Ophiuroidea: Euryalidae).

ABSTRACT

The genus *Asteromorpha* Lütken (Echinodermata: Ophiuroidea: Euryalidae: Euryalinae) is revised based on 52 specimens, including six syntypes of *A. steenstrupi*, one syntype of *A. perplexum* (Koehler), one syntype of *A. koehleri* (Döderlein) and the holotype of *Astroschema capensis* Mortensen. A new combination of *Asteroschema capensis* (Euryalidae: Asteroschematinae) with the genus *Asteromorpha* is proposed. Consequently, *Asteromorpha* includes four species: *A. capensis*, *A. koehleri*, *A. rousseaui*, and *A. tenax*. These four species are all redescribed. A taxonomic key to the species of the genus *Asteromorpha* is also provided.

INTRODUCTION

The snake stars of the genus *Asteromorpha* (Ophiuroidea: Euryalida: Euryalidae: Euryalinae) are known from deep-waters (75-382m) of the south-western Indian Ocean, off Reunion (Michelin, 1862; Lütken, 1869; De Loriol, 1893a), and from the south-western Pacific Ocean, eastern Indonesia and eastern Australia (Döderlein, 1898, Koehler, 1905a, Döderlein, 1911, Koehler, 1930, Mortensen, 1933e, Baker, 1980). They have an oral bridge on the oral side of the vertebrae, arm spines with smooth lamina on the distal portion of the arms, and a body covered by plate-shaped external ossicles.

This genus was erected by Lütken (1869), who designated *Asteromorpha steenstrupi* Lütken, 1869 as the genotype. Later, Lyman (1872) synonymised the genus *Asteromorpha* with the genus *Asteroschema* Oersted and Lütken, 1856 (in Lütken, 1856) (Euryalidae: Asteroschematinae) and synonymised *Asteromorpha steenstrupi* with *Asteroschema rousseaui* Michelin, 1862. For the next 60 years, *Asteromorpha* was considered to be a junior synonym of *Asteroschema*, until Mortensen (1933e) separated *Asteromorpha* from *Asteroschema* as a valid genus and synonymised the monotypic genus *Ophiogelas* (with *O. perplexum* Koehler, 1930 as type) with *Asteromorpha* (Mortensen, 1933e). Mortensen (1933e) included *Asteromorpha rousseaui* (Michelin, 1862) and *Asteromorpha perplexum* (Koehler, 1930) in *Asteromorpha*. Mortensen (1933e) also suggested that *Astroschema koehleri* Döderlein, 1898 should be transferred to the genus *Asteromorpha* and *Asteromorpha perplexum* is a junior synonym of *Asteromorpha koehleri* (Döderlein, 1898) in postscript (see Mortensen, 1933e: 73). However, detailed justification for the synonymy of the two species has never been discussed. Baker (1980) included *A. rousseaui*, *A. koehleri* (Döderlein, 1898), and a new species *A. tenax* Baker, 1980 in *Asteromorpha* in his work of the euryalids from Australia and New Zealand. This genus is currently composed of three species: *A. rousseaui*, *A. koehleri* and *A. tenax*.

External features of species in the genus *Asteromorpha* and some of the species of *Asteroschema* are very similar and species can almost only be distinguished from each other by differences in the internal vertebral ossicle morphology (Mortensen, 1933e). However, the traditional taxonomic descriptions of *Asteromorpha* and *Asteroschema* depended on external morphology. Some species of *Asteromorpha* were originally described as *Asteroschema* and vice versa, i.e., *A. rousseaui* and *A. koehleri* were originally described as species of *Asteroschema*, while *Asteroschema laevis* (Lyman, 1872) was originally described as a species of *Asteromorpha*. The genus *Asteroschema* now includes 35 valid species, but the specific taxonomy has never been sufficiently investigated (Okanishi and Fujita, 2009; Okanishi *et al.*, 2011b; Parameswaran and Jaleel, 2012). Therefore, some species of *Asteroschema* may in fact be *Asteromorpha*. *Asteroschema capensis* Mortensen, 1925 has distinct external features, such as two arm spines on the basal portion of the arms (Mortensen,

1925) and Okanishi and Fujita (2009) questioned its taxonomic position. *Asteroschema capensis* has only been described once and the similarity to *Asteromorpha* has never been discussed.

In this study, specimens examined included eight type specimens and 43 additional specimens of *Asteromorpha* and the holotype of *Astroschema capensis* Mortensen, 1925, which has led to the conclusion that *A. perplexum* is certainly a junior synonym of *A. koehleri,* as Mortensen (1933e) suggested, and *Asteroschema capensis* is a species of the genus *Asteromorpha*.

MATERIAL AND METHODS

The 52 specimens examined in this study are deposited in the Durban Natural Science Museum, South Africa (DNSM), the Zoologische Staatssammlung München, Germany (ZSM), the Muséum National d'Histoire Naturelle, France (MNHN), the National Museum of Natural History, Smithsonian Institution, USA (USNM), the Museum of Comparative Zoology, Harvard University, USA (MCZ) and Museum Victoria, Australia (MV).

The specimens of *Asteroschema capensis* [=*Asteromorpha capensis*] in MNHN and MV F111585 were fixed in 70% ethanol, DNSM ECH1 was dry while fixation methods of all other examined specimens are unknown.

Ossicles were isolated by immersion in domestic bleach (*c.* 5% sodium hypochlorite solution), washed in deionised water, dried in air, and mounted on SEM stubs using double-sided conductive tape. The preparations were sputter-coated with gold-palladium and examined with a Jeol JSM 6380 LV Scanning Electron Microscope (SEM).

In recent descriptions, the term "epidermal ossicles" was used for superficial ossicles of euryalid ophiuroids (Okanishi *et al.*, 2011b). However, the use of the term "external ossicles" in this study is for these ossicles, because epidermis is frequently lost in echinoderms. The relative size and thickness of external ossicles is presented in terms of the length of the longest axis and the depth from external to internal side, respectively. The length and thickness are referred to as "long" and "thick" in this study. The length of the ossicles was measured using an ocular micrometer on a binocular stereoscopic microscope without dissecting the ossicles. Some ossicles were dissected and separated, and the thickness of each ossicle was measured. Other terms used to describe euryalid ophiuroids follow those of Okanishi and Fujita (2011), and terms for the structures of the ossicles are those of Martynov (2010). Family-level classification follows that of Okanishi *et al.* (2011a).

TAXONOMIC ACCOUNT

Family Euryalidae Gray, 1840, emend. Okanishi *et al*., 2011
Subfamily Euryalinae Gray, 1840a, emend. Okanishi *et al*., 2011
Asteromorpha Lütken, 1869

Asteromorpha Lütken, 1869: 42-45; Mortensen, 1933e: 57; Baker, 1980: 70-72.
Ophiogelas Koehler, 1930: 42-43.

Type species: *Asteromorpha steenstrupi* Lütken, 1869 (=*Asteroschema rousseaui* Michelin, 1862).

Diagnosis**:** External ossicles on body either plate-shaped, in full contact with each other, or granule-shaped and only partly in contact. Teeth triangular or square. Oral papillae domed, granule-shaped, on lateral side of jaws. Tentacle pores with two arm spines from fourth (rarely fifth) arm segment.

Radial shields may bear large domed tubercles. Oral side of vertebrae with an oral bridge. Lamina of distal arm spines smooth.

Remarks: Based on this study, *Asteromorpha* is currently composed of four species, *A. capensis* (Mortensen, 1925), *A. rousseaui* (Michelin, 1862), *A. koehleri* (Döderlein, 1898), and *A. tenax* Baker, 1980. A tabular key to the species of *Asteromorpha* is provided (Table 5.1).

Species of this genus are distributed in south-eastern Africa, south-western and eastern Australia, central Indonesia and south-eastern New Caledonia (Figure 5.1).

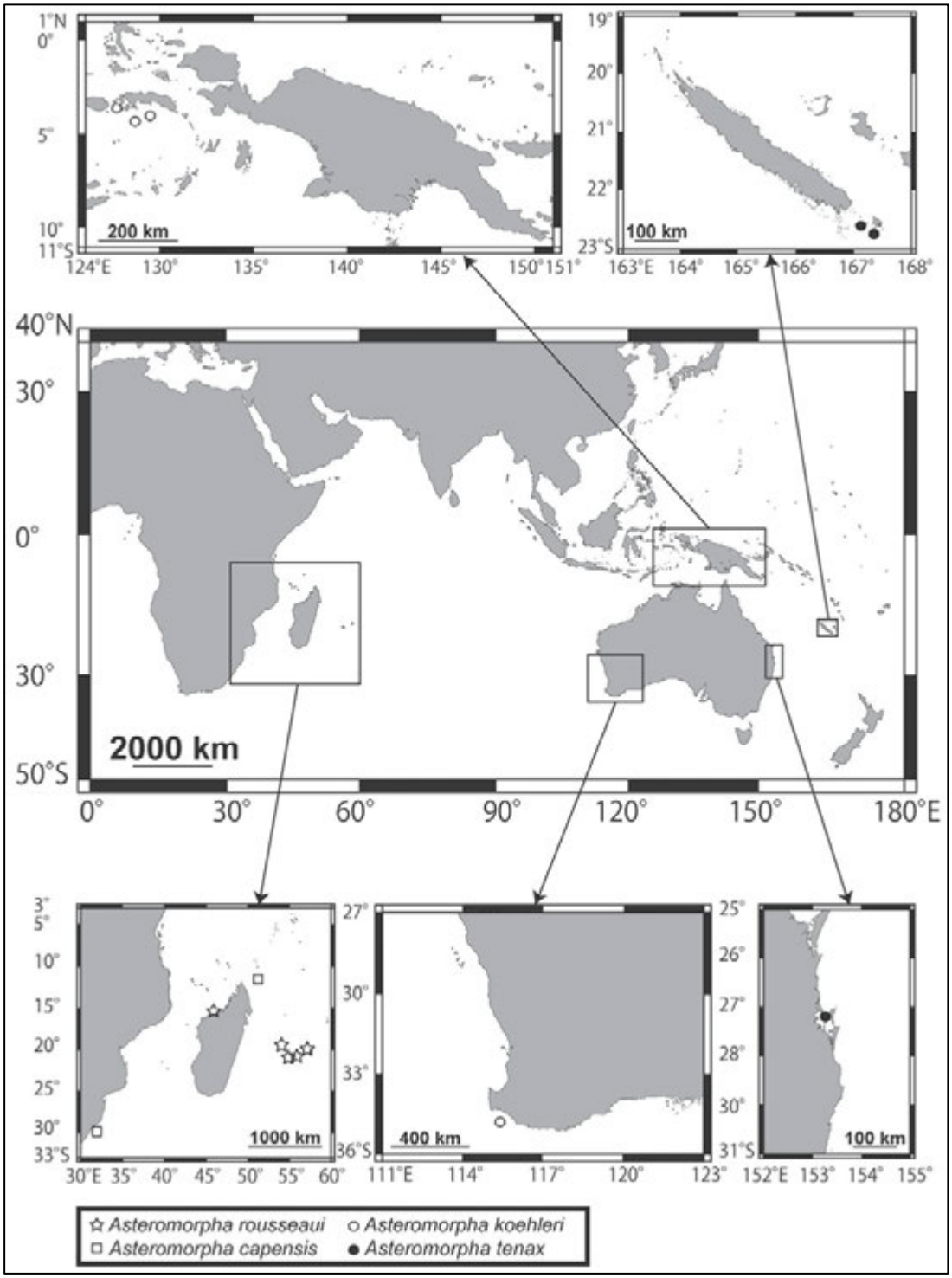

Figure 5.1. Distributions of *Asteromorpha capensis*, *A. rousseaui*, *A. koehleri* and *A. tenax*.

Table 5.1. Revised characters key to the species of the genus *Asteromorpha*.

Species	Colour, form and arrangements of epidermal ossicles		Tubercles on radial shields	Body colour	Reproduction status
	Aboral surface of disc	Aboral and lateral surface of basal portion of arms			
A. capensis (Mortensen, 1925)	Flat plate-shaped, no regular arrangement.	Flat plate-shaped, no regular arrangement.	Absent.	Two variations: 1) reddish purple with white spots on aboral disc and white bands on middle to distal arms; 2) aborally light brown and orally white.	Non fissiparous.
A. rousseaui (Michelin, 1862)	1) Brown, round and domed, 2) white, polygonal and flat plate-shaped, regularly scattered.	Three rows of brown ossicles appearing among tessellated white ossicles in each arm segment.	Absent.	White with brown spots on radial shields and / or brown interradial radiating lines from disc centre, and brown bands on arms.	Non fissiparous.
A. koehleri (Döderlein, 1898)	1) Brown, round and domed, 2) white, polygonal and flat plate-shaped, regularly scattered.	Two pairs of alternating rows of brown and white ossicles in each arm segment.	Absent.	White with brown spots on aboral disc and brown bands on arms.	Fissiparous.
A. tenax Baker, 1980	Flat plate-shaped, no regular arrangement.	Flat plate-shaped, no regular arrangement.	Present.	Uniformly white.	Fissiparous.

Asteromorpha capensis (Mortensen, 1925)

(Figs 5.2-5.5)

Astroschema capensis Mortensen, 1925: 152-155, pl. 8, figs 4-5, text-fig. 5; 1933: 221, 227 (new combination).
Asteroschema capensis. Clark and Courtman-Stock, 1976: 130; Sink *et al.*, 2006: 469-470.
Asteroschema capense. Okanishi and Fujita, 2009: 116, 119, 123, 125; Okanishi and Fujita, 2011: 149.

Type material examined

Dry holotype of *Astroschema capensis*, DNSM ECH1, *c.* 29-32km (18-20 miles) off Umvoti River Mouth, eastern South Africa, *c.* 64-73m (35-40 fathoms), Nov.1920 (Figure 5.1).

Other material examined

Two dry specimens, USNM 1201805, Anton Bruun Ridge, northeast coast of Madagascar, 11°37'S, 51°27'E, *R/V Anton Bruun* Stn 465, 67-72m, 18 Dec.1964; one ethanol preserved specimen, deposited in Echinoderm Collection at MNHN, south Madagascar.

Diagnosis

External ossicles on aboral surface of the body plate-shaped, polygonal, tessellated. No regular transverse rows of external ossicles on aboral and lateral surface of the arms. Body reddish-purple with creamy white spots on aboral disc and white bands on aboral and lateral surface of the arms, or body light brown aborally and white orally. No tubercles on radial shields. Five arms, non-fissiparous.

Description of USNM 1201805

Disc diameter 6.3mm, arm length *c.* 34.5mm (Figure 5.2).

Disc five-lobed with notched interradial edges, no obvious fission plane. On aboral surface, radial shields and their surroundings tumid (Figure 5.2A). Aboral surface of disc covered by slightly domed and polygonal plate-shaped external ossicles (Figure 5.2A-C), *c.* 100μm long and 80μm thick on periphery (Figure 5.2B), and *c.* 70μm long and 80μm thick on central area (Figure 5.2C). Radial shields tumid, *c.* 1.25mm long and 0.60-1.25mm wide (Figure 5.2A) and completely covered by external ossicles.

Oral surface of disc entirely covered by flat and round plate-shaped external ossicles, *c.* 70μm long and 60μm thick on periphery (Figure 5.2D, E) and *c.* 100μm long and 100μm thick on oral plates (Figure 5.2D, F). Four square teeth forming a vertical row on dental plate (Figure 5.2F). Six to seven domed oral papillae lying on each side of the jaw (Figure 5.2D, E).

Lateral interradial surface of disc nearly vertical, covered by flat and round plate-shaped external ossicles similar to those on oral surface, *c.* 50-80μm long (Figure 5.2G). Two genital slits in each interradius, 0.90mm long and 0.30mm wide. One oral interradial bulge present suggesting the presence of at least one madreporite plate.

Arms simple, five in number, no abrupt reduction in width of arms. Distal arms tapering gradually. Basal portion of arms 2.0mm wide and 2.1mm high, square in cross-section. Aboral surface arched and oral surface flattened from middle to distal portion of arms.

Basal portion of arms completely covered by slightly domed and polygonal plate-shaped external ossicles, *c.* 100μm long and 70μm thick on aboral and lateral surface (Figures 5.2H, 5.4A, B) and *c.*

70-80µm long and 50µm thick on oral surface (Figure 5.3A). These ossicles densely tessellated (Figures 5.2H, 5.3A). In the middle portion of arms, aboral and lateral surface covered by plate-shaped external ossicles, similar to those on basal portion of arms (Figure 5.3B), *c.* 70-80µm long and 70µm thick. Oral surface covered by flat and round granule-shaped external ossicles, *c.* 40-50µm long and 50µm thick (Figure 5.3C). In distal portion of arms, aboral and lateral surface covered by flat and round granule-shaped external ossicles, *c.* 50µm long and 20µm thick (Figures 5.3D, 5.4C, D). External ossicles on oral surface gradually decreasing in size distally becoming absent near arm tips (Figure 5.3E).

First to third tentacle pores lacking arm spines; fourth pores with one arm spine and from fifth pores, two arm spines (Figure 5.3A). In first third of arms, arm spines ovoid and minute (Figure 5.4H). Inner arm spines *c.* one-third to half-length of corresponding arm segment, while outer arm spines slightly shorter. In second third of arm, arm spines bear fine spinelets at tips (Figure 5.4I). Inner arm spines *c.* two-thirds length of corresponding arm segment, while outer arm spines almost same length as inner ones (Figure 5.3C). In distal third of arms, arm spines hook-shaped, with smooth lamina on distal side (Figure 5.4J). Inner arm spines three-quarters length of corresponding arm segment, while outer arm spines almost same length as inner ones.

Lateral arm plates concealed by external ossicles, with pairs of a muscle and nerve openings, associated with each arm spine articulation (Figure 5.4E). Vertebrae with oral bridge from distal third on arms (Figure 5.4F, G).

Colour
Uniformly light brown aborally and uniformly white orally (Figure 5.3A, D).

Ossicle morphology of DNSM ECH1
Disc diameter 8mm, arm length *c.* 50mm.

Vertebrae in distal portion of arms with oral bridge (Figure 5.4K).

Variation
Some colour variations were observed across the four specimens. Holotype and one alcohol preserved MNHN specimen have white spots on aboral disc and bands on aboral and lateral surface of the arm (Figure 5.5), but the two dry specimens (USNM 1201805) do not have such spots.

Distribution
MADAGASCAR: south and northeast of Madagascar (present study); SOUTH AFRICA: off Umvoti River, 64-73m (Mortensen, 1925).

Remarks
Mortensen (1925) described the present species as *Asteroschema* of the subfamily Asteroschematinae based on external observations. The holotype of *Astroschema capensis* deposited in the Durban Natural Science Museum has oral bridge on oral side of vertebrae of distal portion of arms (Figure 5.4K) and two arm spines from fifth arm segment (Figure 5.5C). These morphological features confirm an affiliation with the Euryalinae (Mortensen, 1933e; Okanishi *et al.*, 2011a). Body being covered mostly by external ossicles and the distal arm spines having a smooth basal lamina, support this species placement in the genus *Asteromorpha*. Thus, it is concluded here that *Asteroschema capensis* should be transferred to the genus *Asteromorpha* of family Euryalinae.

Asteromorpha capensis (Mortensen, 1925) can be distinguished from the other species of *Asteromorpha* by its morphological characters: flat and polygonal plate-shaped external ossicles that are densely tessellated on aboral body; a body that is either reddish-purple with creamy white spots on aboral disc and banded aboral and lateral surfaces of the arms, or light brown aborally and white orally; radial shields that lack tubercles; and five arms, showing no signs of fissiparity. See also remarks under *A. rousseaui* for a detailed account of these taxonomic characters (Table 5.1).

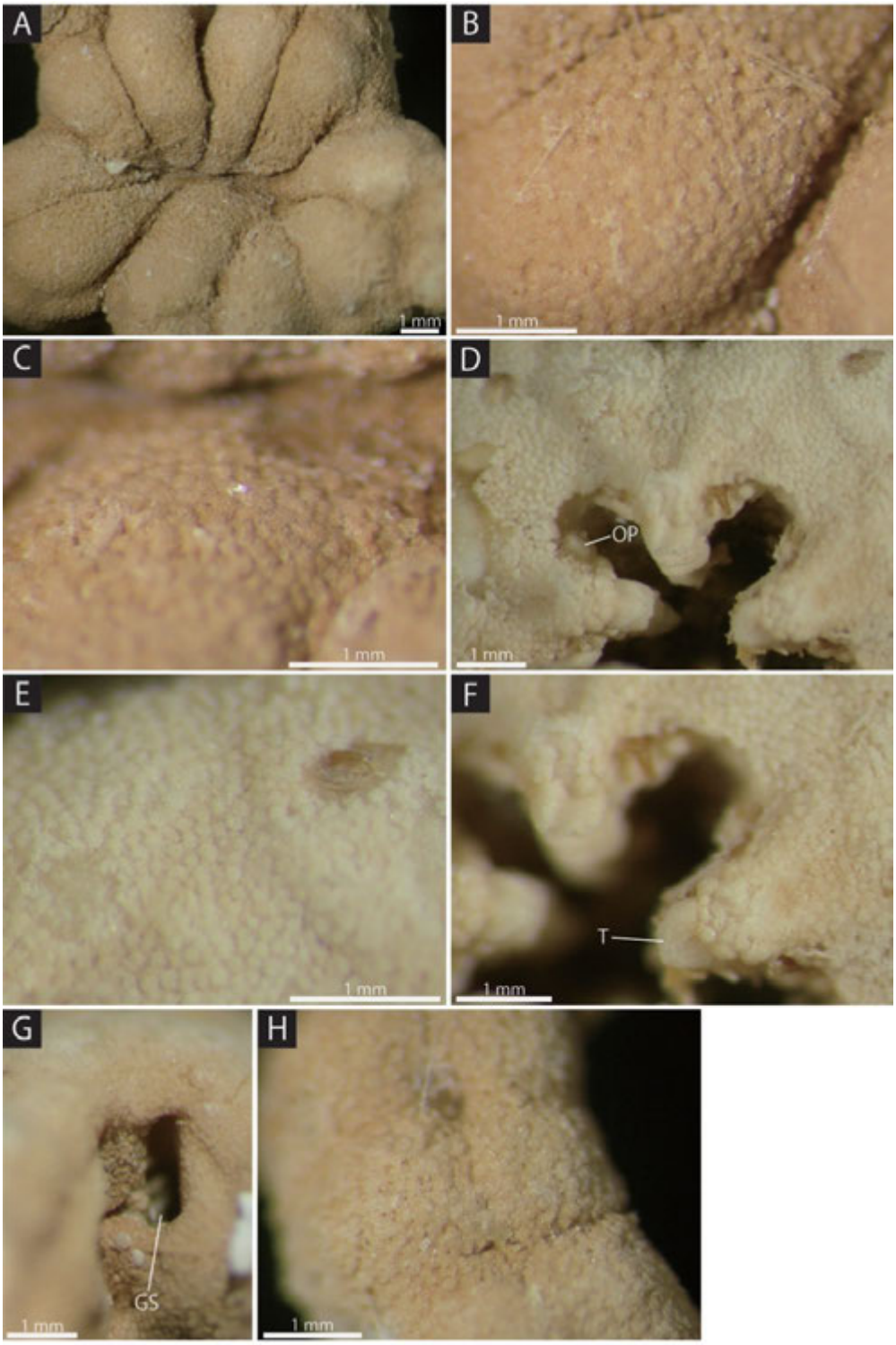

Figure 5.2. *Asteromorpha capensis* (USNM 1201805): A, aboral disc; B, aboral periphery part of disc; C, aboral central part of disc; D, oral disc; E, oral periphery part of disc; F, jaws; G, lateral interradial part of disc; H, aboral basal portion of the arm. Abbreviations: GS: genital slit; OP: oral papillae; T: teeth.

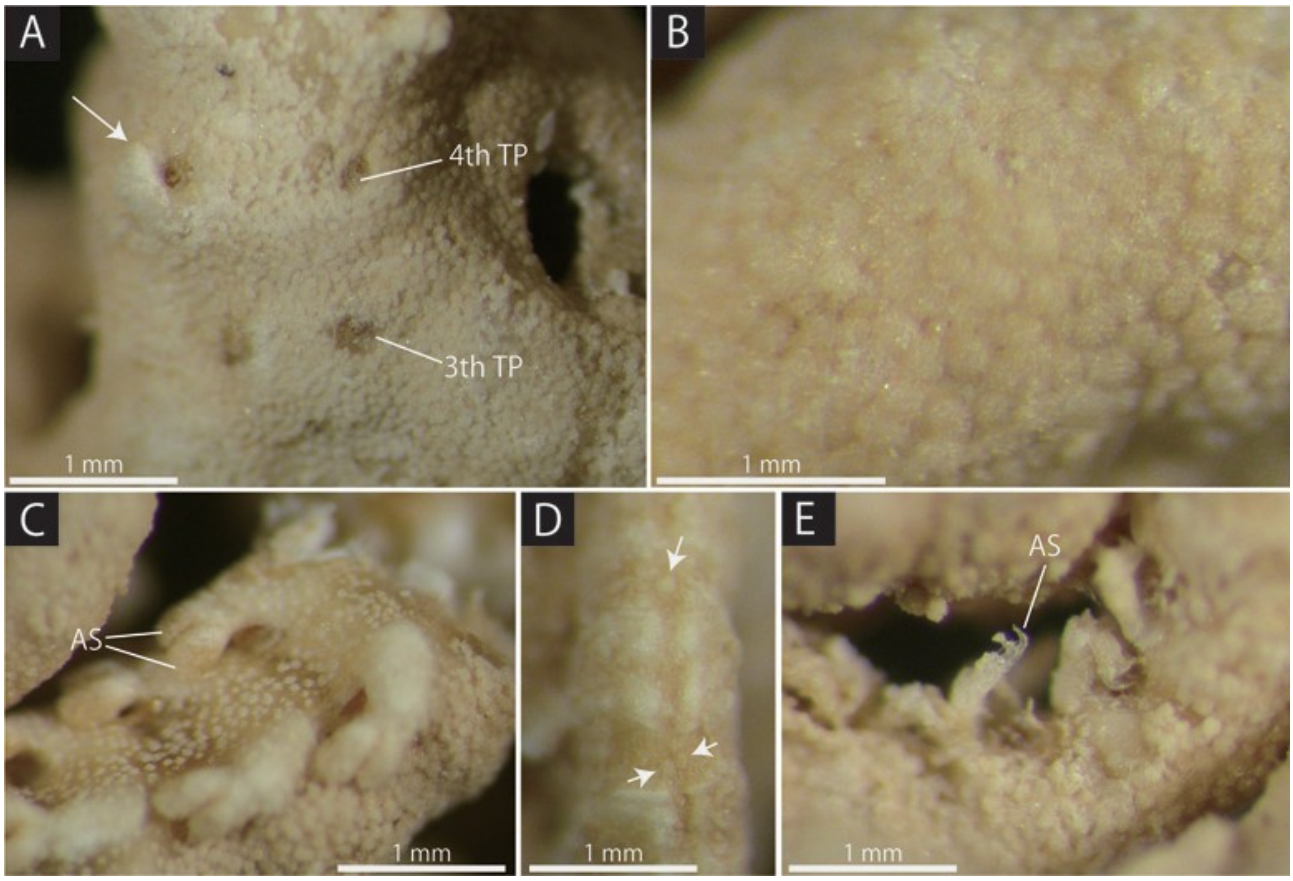

Figure 5.3. *Asteromorpha capensis* (USNM 1201805): A, oral basal portion of the arm; B, aboral middle portion of the arm; C, oral middle portion of the arm; D, aboral distal portion of the arm, tiny and scattered external ossicles are indicated by arrows; E, lateral distal portion of the arm. Abbreviations: AS: arm spine; TP: tentacle pore.

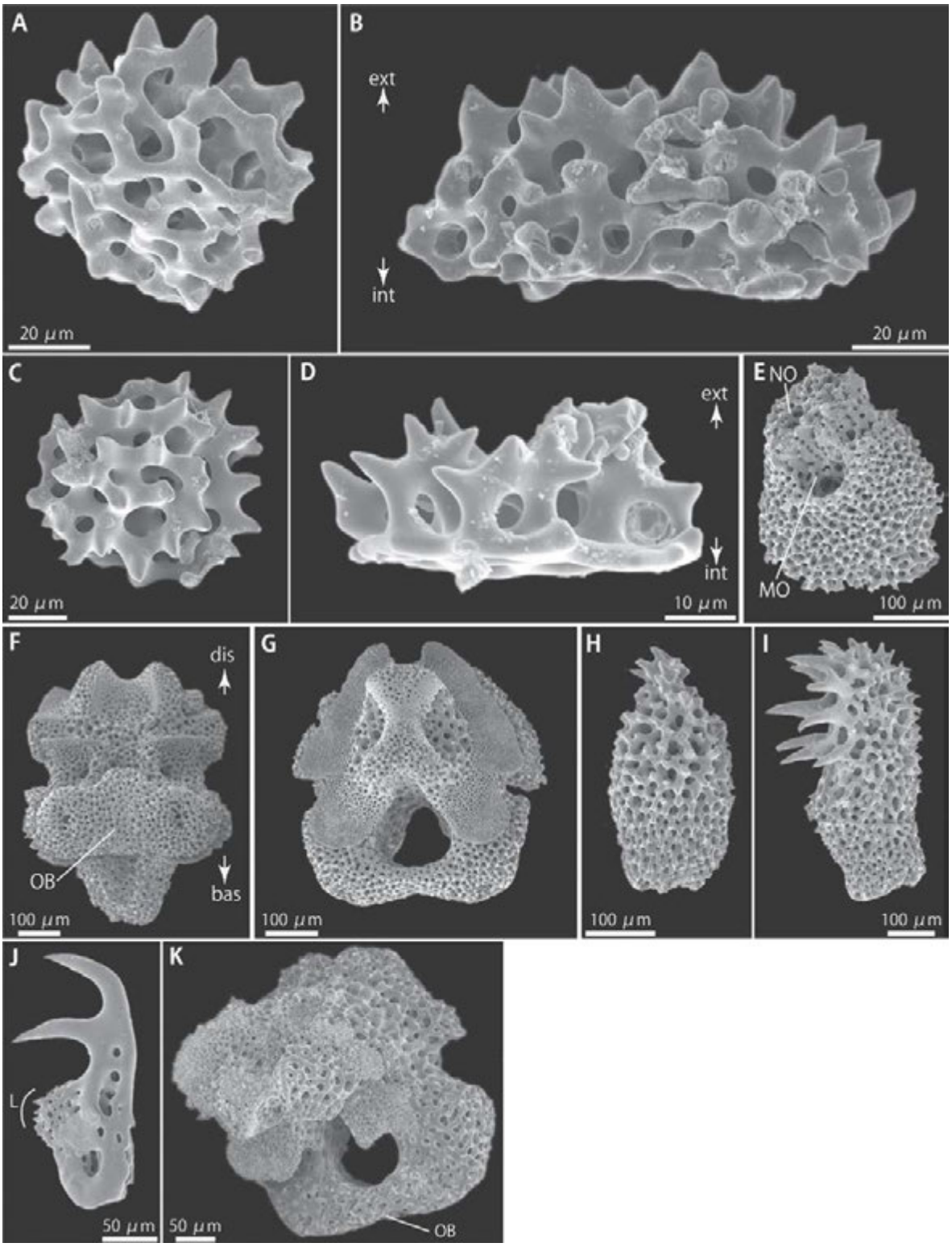

Figure 5.4. *Asteromorpha capensis* (USNM 1201805) (A-J) and (DNSM ECH1: holotype of *Astroschema capensis*) (K), SEM photographs of internal ossicles: A, B, plate-shaped external ossicles at aboral basal portion of the arm, external (A) and lateral (B) views; C, D, granule-shaped external ossicles at distal portion of the arm, external (C) and lateral (D) views; E, lateral arm plate at basal portion of the arm, external view; F, G, vertebrae at distal portion of the arm, oral view (F) and basal view (G); H-J, arm spines from basal portion of the arm (H), middle portion of the arm (I) and distal portion of the arm (J); K, vertebrae at distal portion of the arm, distal view (K). Arrows indicate orientation (B, D, F): bas: basal side; dis: distal side; ext: external side; int: internal side. Abbreviations: L: lamina; MO: muscle opening; NO: nerve opening; OB: oral bridge.

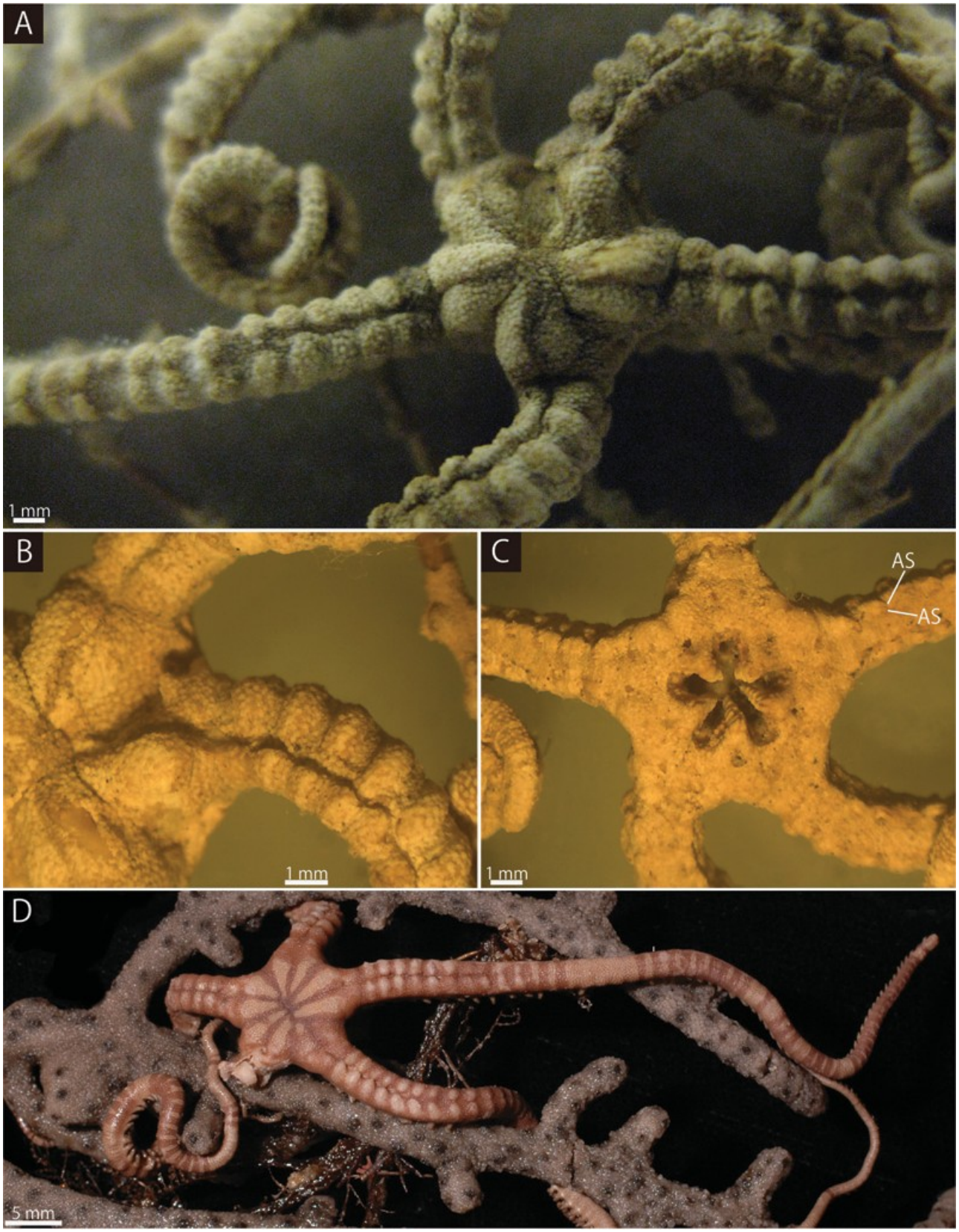

Figure 5.5. *Asteromorpha capensis* (DNSM ECH1: holotype of *Astroschema capensis*) (A-C) and (MNHN specimen) (D): A, aboral view; B, aboral periphery of disc and basal portion of arms; C, oral disc and basal portion of arms, arrows indicate arm spines; D, aboral view. Abbreviation: AS: arm spine.

Asteromorpha rousseaui (Michelin, 1862)

(Figs 5.6-5.9)

Asteroschema rousseaui Michelin, 1862: 6; Hoffman, 1874: 53.
Astroschema rousseaui Von Martens, 1869: 129; Lyman, 1880: 45; Lyman, 1882: 278.
Asteroschema rousseaui Lyman, 1872: 4; De Loriol, 1893a: 55-56; Döderlein, 1911: 111.
Asteromorpha perplexum Clark, 1976: 111, 112, 117, fig. 1, (non *Asteromorpha perplexum* (Koehler, 1930)).
Asteromorpha steenstrupi Lütken, 1869: 60-63, one plate.
Asteromorpha rousseaui Lütken, 1872: 96-98; Mortensen, 1933e: 57-60, figs 42-44, pl. 6, figs 6-9.
Astroschema steenstrupi: Lyman, 1875: 26.
Asteroschema steenstrupi Brock, 1888: 538.

Type material examined

Six dry syntypes of *Asteromorpha steenstrupi*, ZMUC OPH-479, off Reunion.

Other materials examined

One dry specimen, USNM E5956, off Port Louis, Mauritius, 200m, Dec.1929: three ethanol preserved specimens, MNHN IE-2013-4010, IE-2013-4002, IE-2013-4008, collected by *R/V Marion Dufresne*, MD32 CP172, north of Reunion, east of Madagascar, 20°52'S, 55°37'E, 105-120m, 8 Sep.1982: one ethanol preserved specimen, MNHN IE-2013-4011, collected by *R/V Marion Dufresne*, station MD 32 FA92, north of Reunion, east of Madagascar, 19°45'S, 54°07'E, 75-125m, 28 Aug.1982: one ethanol preserved specimen, respectively, MNHN IE-2013-4012, IE-2013-4006, collected by *R/V Marion Dufresne*, MD32 DC176, west of Reunion, east of Madagascar, 21°01'S, 55°10'E, 165-195m, 8 Sep.1982: one ethanol preserved specimen, MNHN IE-2013-8007, collected by *Miriky*, CP3260, between Majunga and Cape Saint-Andre, north-western Madagascar, 15°35'S, 45°45'E, 179-193m, 10 Jul.2009.

Diagnosis

Two types of external ossicles on aboral surface of body, one white, domed and round plate-shaped, the other brown, flat and polygonal plate-shaped. Brown ossicles of disc forming radiating straight rows interradially and / or regularly arranged on radial shields, while the basal portion of arms (aborally and lateral surfaces), bears brown ossicles forming three transverse rows on each arm segment. White ossicles tessellated between these rows. No tubercles on radial shields. Five or six arms, non-fissiparous.

Description of USNM E5956

Disc diameter 6.1mm, arm length *c.* 52mm (Figure 5.6).

Disc circular with no fission plane (Figure 5.6A). Aboral surface tumid, covered by both white, slightly domed and round plate-shaped external ossicles and brown, flat and polygonal plate-shaped external ossicles (Figure 5.6B, C). Brown external ossicles forming five straight rows radiating from centre of disc interradially, and patches of two or three brown external ossicles scattered at regular intervals among white external ossicles on radial shields (Figure 5.6A). White external ossicles *c.* 80-120µm long and 70µm thick and brown external ossicles *c.* 70-100µm long and 30µm thick, respectively. Radial shields triangular, contiguous and completely covered by external ossicles, *c.* 2.7mm long and 1.3mm wide, (Figure 5.6A).

Oral surface of disc entirely covered by only white, flat and polygonal plate-shaped external ossicles (Figure 5.6D), *c.* 60-90µm long and 30µm thick on periphery (Figure 5.6F) and *c.* 100µm long and 40µm thick on oral plates (Figure 5.6E). Four teeth forming vertical row on dental plate. Oral-

most tooth triangular (Figure 5.6E), remaining teeth square, domed oral papillae on each side of the jaws (Figure 5.6E).

Lateral interradial surface of disc nearly vertical, covered by white, flat and polygonal plate-shaped external ossicles similar to those on oral surface (Figure 5.6G). Two genital slits in each interradius, 1.0mm long and 0.40mm wide. Gonads visible inside each genital slit (Figure 5.6G). No distinct ossicles suggesting presence of madreporites visible on oral interradius.

Arms five, simple, basal third and / or fourth arm segments thickened (2.0mm wide and 2.0mm in high), with flattened aboral and oral surfaces. Remaining segments 1.6mm wide and 1.45mm high, with arched aboral surface and flattened oral surface. Arms tapering gradually from middle to distal extremities.

Aboral and lateral surface of basal portion of arms covered by white, slightly domed and round plate-shaped external ossicles, *c.* 100-150µm long and 80µm thick, and brown, domed and round plate-shaped external ossicles, *c.* 100-180µm long and 40µm thick (Figure 5.6H), similar to those on aboral disc.

Basal arm segments (both aboral and lateral surface) covered entirely by white external ossicles interrupted by three transverse rows of brown ossicles. Basal-most row contains only brown ossicles, while other two rows contain regularly scattered white ossicles (Figure 5.6H). Oral surface of arms covered only by flat, polygonal plate-shaped external ossicles, *c.* 50-80µm long and 50µm thick (Figure 5.7A), similar to those on oral disc. In middle portion of arms, aboral and lateral surface also covered by white and brown external ossicles similar to those on basal portion of arms, *c.* 100-130µm long and 100µm thick, and *c.* 70-100µm long and 50µm thick, respectively (Figure 5.7B). Similarly, on arm segments, brown external ossicles form two transverse rows, with basal rows being continuous and distal rows fragmented (Figure 5.7B, D). Oral surface covered by white, flat and polygonal plate-shaped external ossicles, similar to those on basal portion of oral arms, *c.* 50-80µm long and 50µm thick (Figure 5.7C). Distal portion of arms entirely covered by uniform flat and round granule-shaped external ossicles, *c.* 80µm long and 30µm thick (Figure 5.7E, F). Each arm segment with row of brown external ossicles on aboral and lateral surface (Figure 5.7F).

First to third tentacle pores lacking arm spines, then two arm spines from fourth pore (Figure 5.7A). In first third of arms, arm spines ovoid and minute (Figure 5.8F), with inner arm spines *c.* one-third of length of corresponding arm segment and outer arm spines four-fifths of length of inner ones (Figure 5.8F). In second third of arms, arm spines bearing fine spinelets at tips (Figure 5.8G). Inner arm spines two-thirds of length of corresponding arm segment and outer arm spines half-length of inner ones (Figures 5.7C, D, 5.8G). In distal third of arms, arm spines hook-shaped with smooth lamina on distal side (Figure 5.8H). Inner arm spines half-length of corresponding arm segment with outer arm spines almost same length as inner ones (Figures 5.7E, 5.8H). Lateral arm plates concealed by external ossicles, with one or two pairs of a muscle and a nerve opening, and each of them associated with an arm spine articulation (Figure 5.8E). Vertebrae in middle to distal portion of arms with oral bridge (Figure 5.8I).

Colour

Aboral disc surface, five brown lines radiating interradially from disc centre. Radial wedges are defined by scattered brown spots that form dashed concentric triangle (Figure 5.6A-5.6C). Aboral and lateral surface of arms white with brown transverse rows. Configuration of brown rows outlined above (Figures 5.6H, 5.7B, D). Oral surface uniformly white.

Variation

Some colour variations were observed, as Mortensen (1933e) indicated. The specimens MNHN IE-2013-4006, IE-2013-4002, IE-2013-4008, IE-2013-8007 show similar colour to USNM E5956 described above and have radiating rows of brown plate-shaped external ossicles on aboral disc (Figure 5.6A). However, syntypes of *A. steenstrupi* and specimens of MNHN IE-2013-4010, IE-2013-4011, IE-2013-4012 show no such rows or scattered brown ossicles on the aboral disc (Figure 5.9A). Brown transverse rows appear on arms of all examined specimens (Figure 5.9A, B).

Distribution

REUNION: around Reunion Island, 75-195m (Lütken, 1869; present study). MAURITIUS: off Port Louis, 200m (present study); northwest of Majunga, 179-193m (present study).

Remarks

According to Mortensen (1933e) and Baker (1980), *A. rousseaui* can be distinguished from other species by: 1) absence / presence of oral bridge of vertebrae in the basal portion of the arms; 2) fissiparous / non-fissiparous; 3) absence / presence of tubercles on radial shields; and 4) absence / presence of transverse rows of external ossicles on aboral and lateral surface of the arms.

Mortensen (1933e) found that *A. rousseaui* possesses an oral bridge only in distal portion of the arms, but the other species of *Asteromorpha* possess it throughout the arms (Mortensen, 1933e). In this study, this character is not used to distinguish the species, because it might be variable depending on growth stage. Mortensen (1933e) examined specimens of *A. rousseaui* that were much larger than those of *A. perplexum* (Mortensen, 1933e). To determine the reliability of this character, examination of a series of smaller specimens of *A. rousseaui* is required.

Fissiparity and the absence / presence of tubercles on radial shields were useful taxonomic characters for distinguishing *A. rousseaui*. All examined specimens in this study of *A. capensis* (n = 4) and *A. rousseaui* (n = 14) have five or six arms that are uniform in width and have no fission plane. On the other hand, 12 of 18 (67%) examined specimens of *A. koehleri* and 12 of 16 (75%) of *A. tenax* have fission planes and six arms with a different width (see *Remarks* of these two species). Twelve of 16 (75%) examined specimens of *A. tenax* (including specimens both with / without fission planes) have large tubercles on the radial shields, which are absent in *A. rousseaui* (see *Remarks* of each species; and Table 5.1).

Presence / absence of transverse rows of brown external ossicles on the aboral and lateral surfaces of the arms also proved to be a useful taxonomic character, but may require more rigorous investigation. Of the four *Asteromorpha* species, the transverse rows only occur in *A. rousseaui* and *A. koehleri*. In the basal portion of the arms, *A. koehleri* has two rows and *A. rousseaui* has three (Table 5.1). In this study, the number of rows of external ossicles was also a useful diagnostic character that can distinguish *A. rousseaui* from *A. koehleri*.

In this study of 52 specimens of *Asteromorpha* revealed that body colour is a useful diagnostic character. *A. rousseaui* has brown spots at regular intervals and / or brown interradial radiating lines on aboral disc and brown bands on arms. *A. koehleri* is similar to *A. rousseaui* in colour, but lacks brown interradial radiating lines on aboral disc (see Table 5.1).

Mortensen (1933e) recognised two colour variations in *A. rousseaui* (see *Variation* above). These variations are distinct and could possibly be distinguished as different species or subspecies.

However, the type specimens of *A. rousseaui* were not examined and these variations are not described as different (sub)species here. If the type specimens of *A. rousseaui* have no radiating interradial lines like the syntypes of *A. steenstrupi,* then *A. steenstrupi* should be retained as a synonym of *A. rousseaui*, and specimens with the radiating lines should be described as a new species. However, if the type specimens of *A. rousseaui* have radiating lines, then *A. steenstrupi* could be revived. It is unfortunate that the colour pattern was not sufficiently detailed in the original description of *A. rousseaui* (Michelin, 1862). Therefore, examination of the type specimens of *A. rousseaui* is required for determining the taxonomic status of these two colour variations. Jangoux (1985) noted that the type specimen(s) were deposited in Museum d'Histoire Naturelle de Lyon. However, the whereabouts of the type specimens are unknown at present (Sabine Stöhr, pers. comm.).

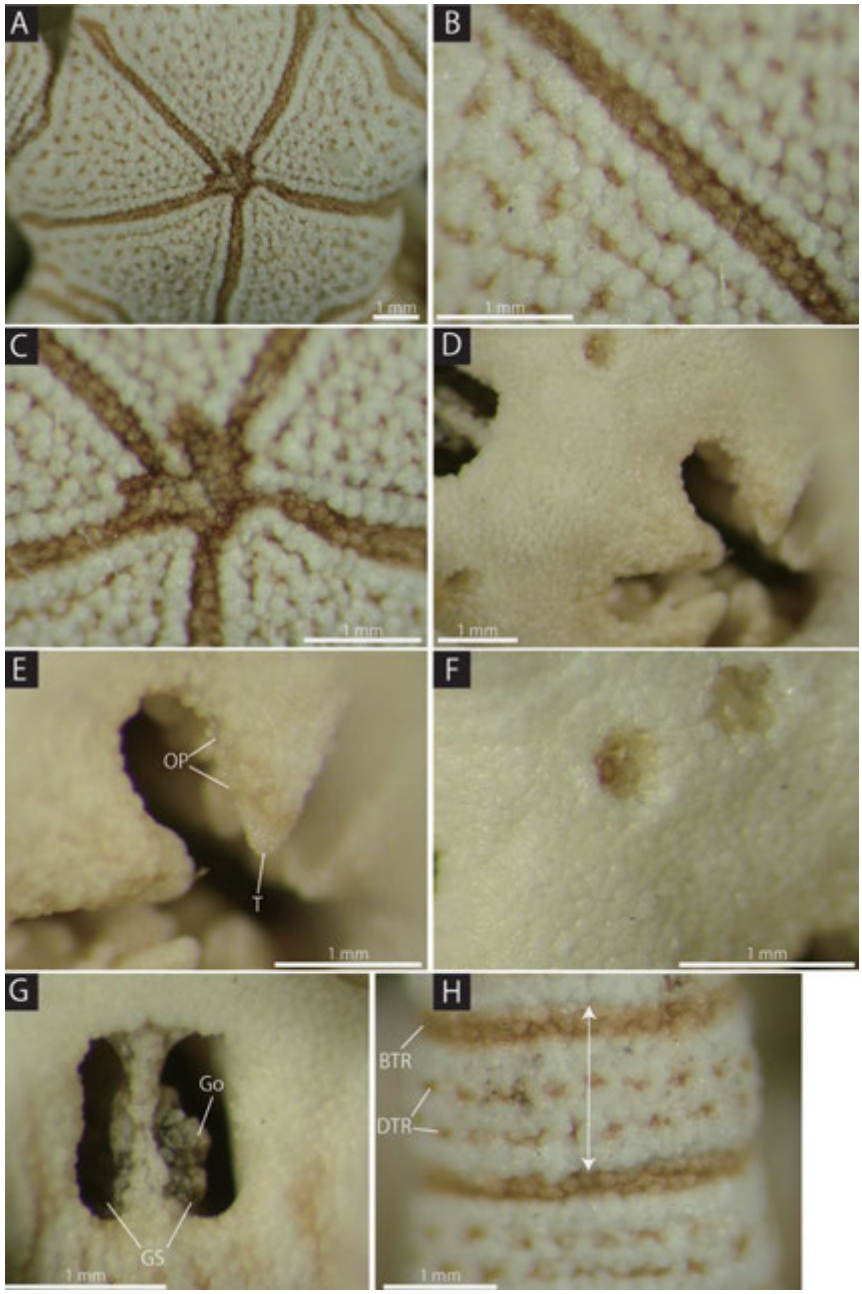

Figure 5.6. *Asteromorpha rousseaui* (USNM E5956): A, aboral disc; B, aboral periphery part of disc; C, aboral central part of disc; D, oral disc; E, jaws; F, oral periphery of disc; G, lateral interradial part of disc; H, aboral basal portion of the arm. Double arrow indicates an arm segment. Abbreviations: BTR: basal transverse row; DTR: distal transverse row; Go: Gonad; GS: genital slit; OP: oral papillae; T: teeth.

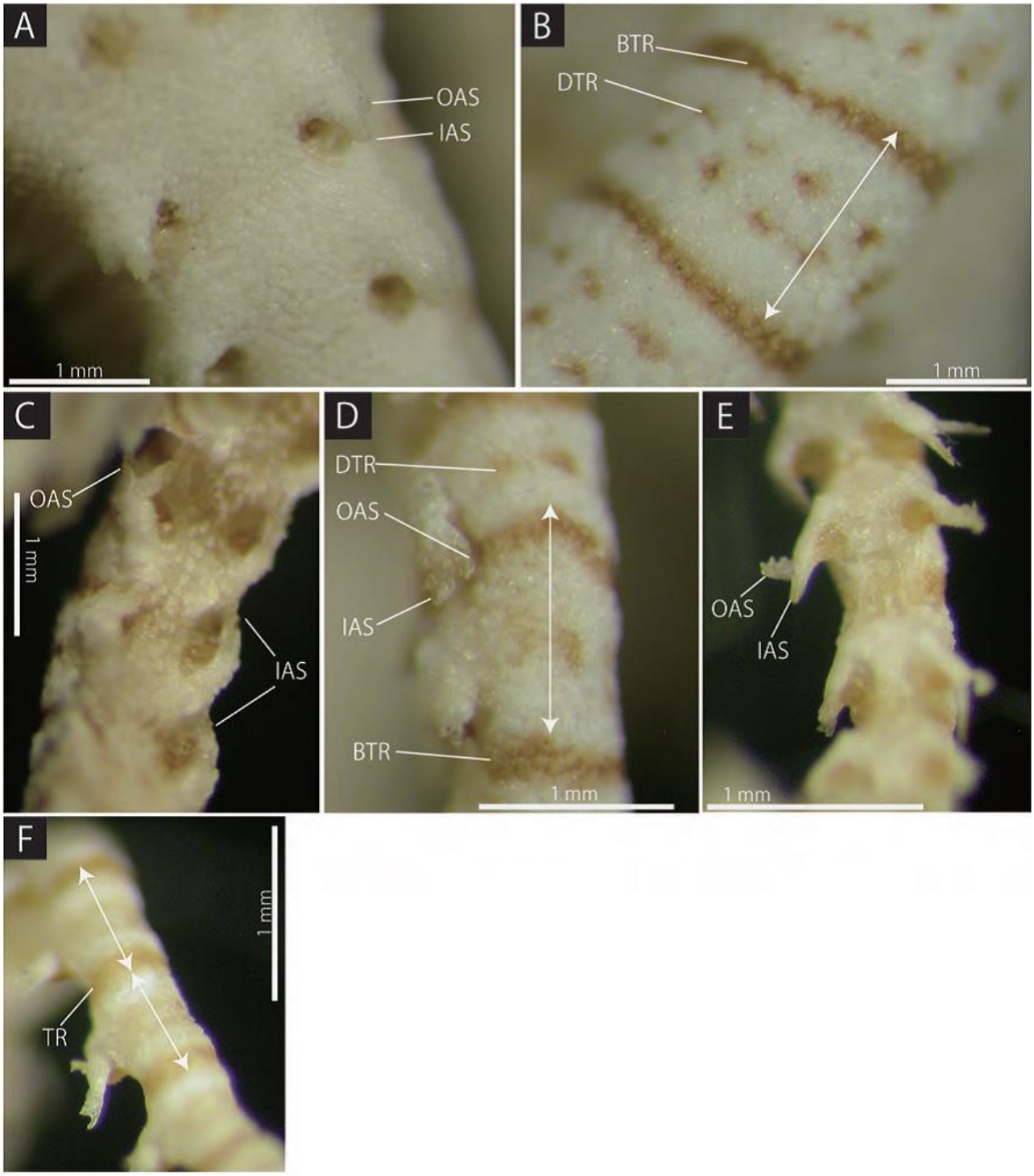

Figure 5.7. *Asteromorpha rousseaui* (USNM E5956): A, oral basal portion of the arm; B, aboral middle portion of the arm, double arrow indicates an arm segment; C, oral middle portion of the arm; D, aboral distal portion of the arm, double arrow indicates an arm segment; E, oral distal portion of the arm; F, lateral distal portion of the arm. Double arrows indicate arm segments. Abbreviations: BTR: basal transverse row; DTR: distal transverse row; IAS: inner arm spine; OAS: outer arm spine; TR: transverse row.

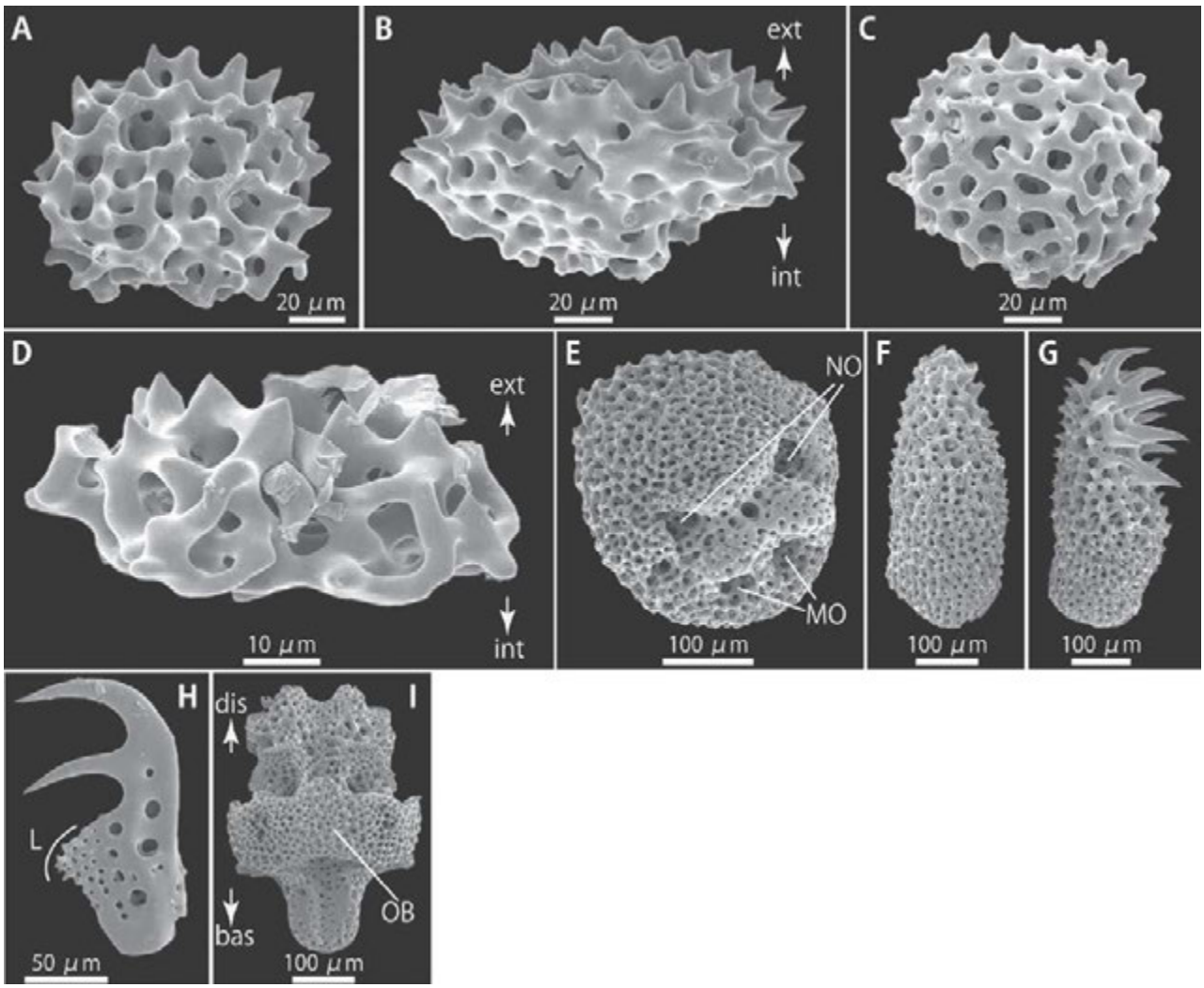

Figure 5.8. *Asteromorpha rousseaui* (USNM E5956), SEM photographs of internal ossicles: A, B, white and domed plate-shaped external ossicles at aboral basal portion of the arm, external (A) and lateral (B) views; C, D, brown and flat plate-shaped external ossicles at oral basal portion of the arm, external (C) and lateral (D) views; E, lateral arm plate at basal portion of the arm, external view; F-H, arm spines from basal portion of the arm (F), middle portion of the arm (G) and distal portion of the arm (H); I, vertebrae at distal portion of the arm, oral view. Arrows indicate orientations (B, D, I), bas: basal side; dis: distal side; ext: external side; int: internal side. Abbreviations: L: lamina; MO: muscle opening; NO: nerve opening; OB: oral bridge.

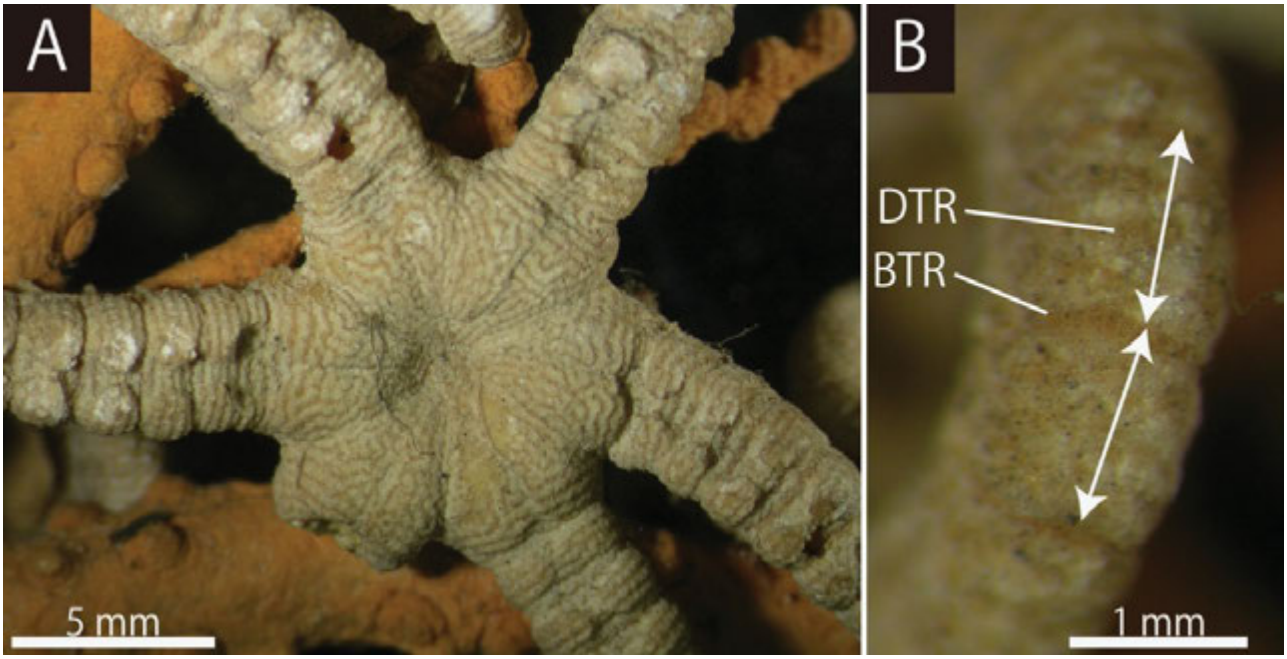

Figure 5.9. *Asteromorpha steenstrupi* Lütken, 1869, one syntype (ZMUC OPH-479): A, aboral disc and basal portion of arms; B, aboral middle portion of arm. Double arrows indicate arm segments. Abbreviations: BTR: basal transverse row; DTR: distal transverse row.

Asteromorpha koehleri (Döderlein, 1898)

(Figs 5.10-5.12)

Astroschema koehleri Döderlein, 1898: 131-132, pls 5, 5a.
Asteroschema koehleri Döderlein, 1911: 111.
Astroschema rousseaui Koehler, 1905a: 123; (non *Asteromorpha rousseaui* (Michelin, 1862)).
Ophiogelas perplexum Koehler, 1930: 43-45, pls 2, 6; pls 4, 9-12.
Asteromorpha perplexum Mortensen, 1933e: 60-62, 73, figs 45, 46.

Materials examined

One ethanol preserved syntype of *Astroschema koehleri*, ZSM 424/1, off Ambon, eastern Indonesia: dry holotype of *Ophiogelas perplexum*, MCZ E5864, off Ambon, eastern Indonesia, 125m; 16 ethanol preserved specimens, MV F111585, collected by *R/V Southern Surveyor*, SS10/2005 18, off D'Entrecasteaux National Park, 34°53'S, 115°30'E to 34°53'S, 115°29'E, 95-100m, 21 Nov.2005.

Diagnosis

Two types of external ossicles on aboral surface of body, white, domed and round plate-shaped ossicles and brown, flat and polygonal plate-shaped ossicles. Brown ossicles regularly arranged on radial shields. External ossicles on aboral and lateral surface of arms forming alternating transverse rows of brown and white ossicles on each arm segment. Two rows of brown ossicles on each arm segment in basal portion of arms. No tubercles on radial shields. Usually six arms, fissiparous.

Description of MCZ E5864

Disc diameter 2.3mm, arm length at least 12mm (arms convoluted).

Disc six-lobed in shape with no fission plane. Aboral surface tumid in radial regions, covered by white, domed and round plate-shaped external ossicles, as well as brown, flat and round plate-shaped external ossicles (Figure 5.10A-C). Aboral surface of disc covered by white external ossicles, with brown external ossicles scattered at regular intervals (Figure 5.10B, C). White external ossicles and brown external ossicles *c.* 70-110µm long and 30-40µm long, respectively (Figure 5.10B, C). Radial shields oval, completely covered by external ossicles, *c.* 1.1mm long and 0.4mm wide (Figure 5.10A, C).

Oral surface of the disc entirely covered by only white, flat and polygonal plate-shaped external ossicles, *c.* 80µm long (Figure 5.10D). Three to four teeth forming a vertical row on dental plate, except on two jaws that have two parallel teeth in oral-most position (Figure 5.10D). Four to five domed oral papillae lying on each side of the jaw (Figure 5.10D).

Lateral interradial surface of disc nearly vertical, covered by white, flat and polygonal plate-shaped external ossicles, similar to those on oral surface (Figure 5.10E). Two narrow genital slits in each interradius, 50µm long and 7.5µm wide. No distinct ossicles suggesting existence of madreporites (Figure 5.10E).

Arms simple, six. Two arms thickened (0.9mm and 0.7mm width, respectively) on basal third to fourth segments with flattened aboral and oral surfaces. Remaining segments, 0.3mm in width, with arched aboral surface and flattened oral surface. Arms tapering gradually towards tip of arm from middle. Remaining four arms flattened on both aboral and oral surfaces, square in cross-section and tapering gradually towards arm tip.

In basal portion of arms, aboral and lateral surface completely covered by white, domed and round plate-shaped external ossicles, *c.* 90-105µm long, and brown, flat and round plate-shaped external

ossicles, *c.* 45-60µm long (Figure 5.10C), similar to those on aboral disc. Each arm segment entirely covered by two pairs of brown and white external ossicles forming alternately arranged transverse rows (Figure 5.10C). Oral surface covered by white, flat and polygonal plate-shaped external ossicles *c.* 45-60µm long (Figure 5.10F), similar to those on oral surface. In middle portion of arms, the aboral and lateral surface also covered by white and brown external ossicles similarly arranged to those on basal portion of arms, both *c.* 60µm long (Figure 5.11A). Oral surface covered by white, flat and polygonal external ossicles, similar to those on basal portion of the arms, *c.* 45µm long. The distal aboral and lateral surfaces covered only with white granule-shaped external ossicles, *c.* 45µm long (Figure 5.11B). No external ossicles on oral surface of distal portion of arms.

First to third tentacle pores lacking arm spines, then two arm spines from fourth pores (Figure 5.10F). In first third of arms, arm spines ovoid (Figure 5.10F) with inner and outer arm spines almost same length, approximately half the length of corresponding arm segment (Figure 5.10F). In second third of arms, inner arm spines half-length of corresponding arm segment with outer arm spines four-fifths length of inner one (Figure 5.11A) and from first third to midpoint of that, arm spines cylindrical (Figure 5.11A) and from that midpoint to second third of the arm, arm spines hook-shaped (Figure 5.11A). In distal third of arms, all arm spines hook-shaped, inner arm spines half-length of corresponding arm segment and outer arm spines almost same length as inner ones (Figure 5.11B).

Colour

Aboral surface of disc white with brown spots scattered between white ones at regular intervals (Figure 5.10A). Arms banded from basal to middle portion of arms on aboral and lateral surfaces, (Figures 5.10C, 5.11A). Distal portion of aboral arms (Figure 5.11B) and whole oral surface uniformly white.

Ossicle morphology of MV F111585

Disc diameter 3.2mm, arm length *c.* 20mm.

White and domed plate-shaped external ossicles on aboral surface of middle portion of arms, *c.* 80µm long and 40µm thick (Figure 5.12A, B) and white granule-shaped external ossicles on aboral surface of distal portion of arms, *c.* 50µm long and 20µm thick (Figure 5.12C, D). Lateral arm plates in middle portion of arms with one or two pairs of a muscle and a nerve opening, and each of them associated with arm spine articulation (Figure 5.12E).

Vertebrae with oral bridge in distal portion of arm (Figure 5.12F, G). Arm spines for first third of arms ovoid and minute (Figure 5.12H) with remaining arm spines hook-shaped with inner teeth and smooth lamina on distal side gradually decreasing in size (Figure 5.12I, J).

Variation

This specimen and a syntype of *Astroschema koehleri* (Döderlein, 1898) show irregular brown bands on aboral and lateral surface of basal to middle portion of the arms, but 16 specimens from south-western Australia show thicker brown bands every three to five arm segments. This specimen shows an abrupt gap on basal portion of the arms in thickness, but this is not evident in any of the other specimens examined.

Distribution

INDONESIA: off Ambon Island and off Kei Island, eastern Indonesia, 90-125m (Döderlein, 1898; Koehler, 1930); AUSTRALIA: off D'Entrecasteaux National Park, south-western Australia, 95-100m (present study).

Remarks

Asteromorpha koehleri was originally described by Döderlein (1898) as a species of the genus *Asteroschema.* Koehler (1930) described *Ophiogelas perplexum* as a monotypic genus. Mortensen (1933e) transferred *O. perplexum* to *Asteromorpha*, synonymising it with *A. koehleri* in a postscript. Baker (1980) also included *A. koehleri* in *Asteromorpha.*

A comparison of a syntype of *Astroschema koehleri* with a syntype of *Ophiogelas perplexum* showed that these species both have alternating transverse rows of white, domed external ossicles and brown, flat external ossicles, both with two pairs of rows in basal portion of the arms. Based on this diagnostic character, it is concluded that the latter species (*O. perplexum*) is a junior subjective synonym of *A. koehleri* as Mortensen (1933e) suggested.

Asteromorpha koehleri (Döderlein, 1898) can be distinguished from the other species of *Asteromorpha* by the following morphological characters: two types of external ossicles on the aboral body, first, white, domed and round plate-shaped ossicles, and second, brown, flat and polygonal plate-shaped ossicles; the radial shields covered in regularly-arranged brown ossicles; on the aboral and lateral surface of the arms transverse rows of white ossicles and brown ossicles alternating; in the basal portion of the arms, two rows of brown ossicles on each arm segment; no tubercles on radial shields; usually six arms and fissiparous (see Table 5.1).

Both *A. rousseaui* and *A. koehleri* have two types of external ossicles on their aboral body. In the basal portion of the arm of aboral and lateral surface, *A. koehleri* has two transverse rows of brown ossicles, while *A. rousseaui* has three (see also *Remarks* on *A. rousseaui* above). *Asteromorpha capensis* and *A. tenax* possess only one type of external ossicles on their aboral body.

Of 18 examined specimens of *A. koehleri*, 17 have six arms and only one has five arms. Twelve of the 17 six-armed specimens show conspicuous fission planes in their discs which suggests that *A. koehleri* is fissiparous. *Asteromorpha tenax* is also fissiparous (see also *Remarks* of *A. tenax*), while *A. capensis* and *A. rousseaui* are non-fissiparous.

A. koehleri can be distinguished from *A. tenax* by having no tubercles on their radial shields (see also *Remarks* of *A. tenax*).

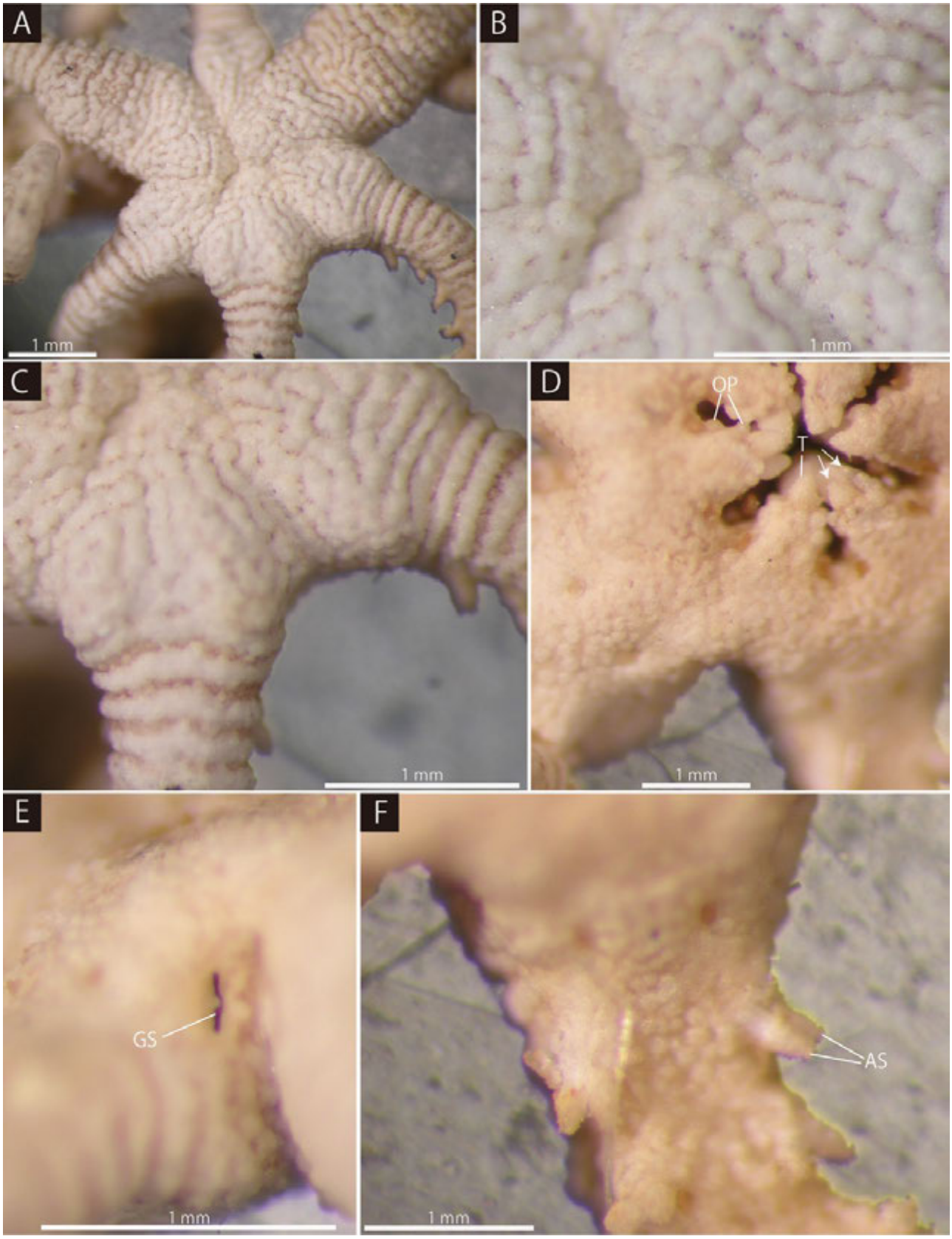

Figure 5.10. *Asteromorpha koehleri* (MCZ E5864: holotype of *Ophiogelas perplexum*): A, aboral disc and basal portion of arms; B, aboral central part of disc; C, aboral periphery part of disc and basal portion of arms; D, oral disc, two parallel oral-most teeth are indicated by arrows; E, lateral interradial part of disc; F, basal portion of oral arm. Abbreviations: AS: arm spine; GS: genital slit; T: teeth; OP: oral papillae.

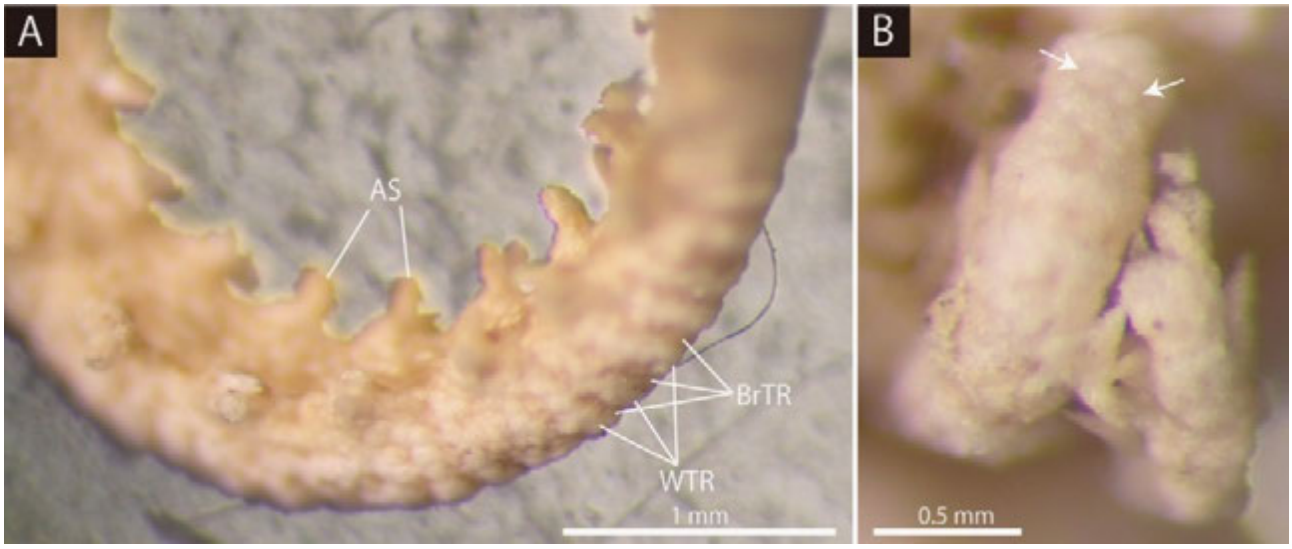

Figure 5.11. *Asteromorpha koehleri* (MCZ E5864: holotype of *Ophiogelas perplexum*): A, lateral middle portion of the arm; B, aboral distal portion of the arm, tiny and scattered external ossicles are indicated by arrows. Abbreviations: AS: arm spine; BrTR: brown transverse row; WTR: white transverse row.

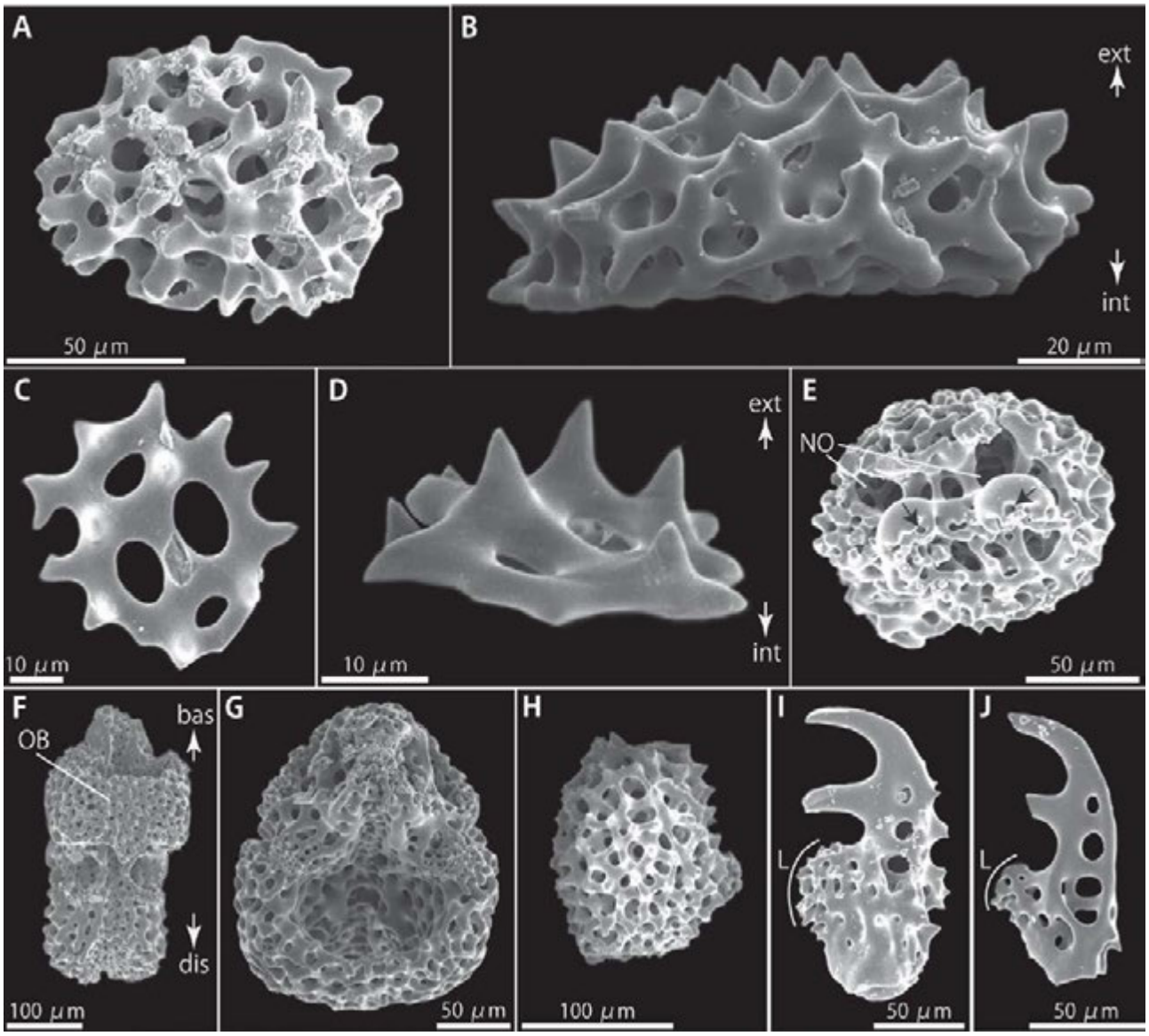

Figure 5.12. *Asteromorpha koehleri* (MCZ E5864: holotype of *Ophiogelas perplexum*), SEM photographs of internal ossicles: A, B, plate-shaped external ossicles at aboral basal portion of the arm, external (A) and lateral (B) views; C, D, granule-shaped external ossicles at distal portion of the arm, external (C) and lateral (D) views; E, lateral arm plate at middle portion of the arm, external view, muscle openings are indicted by arrows; F, G, vertebrae at distal portion of the arm, oral view (F) and basal view (G); H-J, arm spines from basal portion of the arm (H), middle portion of the arm (I) and distal portion of the arm (J). Arrows indicate orientations (B, D, F): bas: basal side; dis: distal side; ext: external side; int: internal side. Abbreviations: L: lamina; NO: nerve opening; OB: oral bridge.

Asteromorpha tenax Baker, 1980

(Figs 5.13-5.15)

Asteromorpha tenax Baker, 1980: 70-72, figs 26a, 32.

Materials examined

Twelve ethanol preserved specimens, MNHN IE-2013-4009, collected by the *R/V Vauban*, station DW205, southeast of New Caledonia, 22°38'S, 167°07'E, 140-160m, 27 Sep.1989: four ethanol preserved specimens, MNHN IE-2013- 4003, collected by the *R/V Le Suroit*, station PL18, southeast of New Caledonia, 22°46'S, 167°20'E, 70-301m, 3 Sept.1989.

Diagnosis

External ossicles on aboral surface of body polygonal plate-shaped, densely tessellated. No regular transverse rows of external ossicles on aboral and lateral surface of arms. Body uniformly white. Large tubercles on radial shields. Usually six arms, fissiparous.

Description of MNHN IE-2013-4009

Disc diameter 1.7mm, arm length *c.* 6.6mm (Figure 5.13).

Disc six-lobed with no fission plane (Figure 5.13A). Radial shields and aboral interradial areas slightly tumid (Figure 5.13A). Aboral surface of the disc covered by flat and polygonal plate-shaped external ossicles with three domed and round tubercles (Figure 5.13A, B). On disc, external ossicles *c.* 100µm long and 50µm thick on periphery and *c.* 80µm long and 40µm thick in centre (Figure 5.13B). Tubercles *c.* 4-6mm in length, *c.* 3-4mm in height (Figure 5.13B). Radial shields triangular, completely covered by external ossicles and tubercles, *c.* 0.7mm long and 0.2-0.4mm wide (Figure 5.13A, B).

Oral surface of disc entirely covered by domed and polygonal plate-shaped external ossicles, *c.* 50µm long and 50µm thick (Figure 5.13C, D). Three triangular teeth forming a vertical row on dental plate (Figure 5.13D) with two or three domed oral papillae on either each side of jaw (Figure 5.13D).

Lateral interradial surface of disc nearly vertical, covered by flat and polygonal plate-shaped external ossicles, similar to those on oral surface (Figure 5.13E). Two pore-like genital slits, 0.1mm long and 0.06mm wide in each interradius. No distinct ossicles, suggesting existence of madreporites visible on oral interradius.

Arms simple, six, with no abrupt change in width of arms. Basal portion of arm 0.5mm wide and 0.4mm high, tapering gradually towards arm tip.

Basal portion of arms completely covered by flat and polygonal plate-shaped external ossicles, *c.* 50-100µm long and 50µm thick on aboral and lateral surface (Figure 5.13F), and *c.* 50µm long and 40µm thick on oral surface (Figure 5.13G). These ossicles densely tessellated (Figure 5.13F, G). In middle portion of arms, aboral and lateral surface covered by flat and round granule-shaped external ossicles, *c.* 50µm long and 20µm thick (Figure 5.14A). Orally, external ossicles gradually decreasing in size, disappearing from middle portion of arms. No external ossicles presenting on distal portion of arms (Figure 5.14B).

First to third tentacle pores lacking arm spines, then two arm spines from fourth pores (Figure 5.13G). In first third of arms, arm spines ovoid and minute, both inner and outer arm spines one-third length of corresponding arm segment (Figure 5.13G). In second and distal thirds of arms, arm spines hook-

shaped, their number decreasing to one (Figures 5.14B, 5.15A) which is half the length of corresponding arm segment (Figure 5.14B).

Lateral arm plates concealed by external ossicles (Figure 5.15B). Vertebrae with an oral bridge in distal portion of arms (Figure 5.15C, D).

Colour
Uniformly white (Figures 5.13, 5.14).

Distribution
AUSTRALIA: off Morton Bay, depth unknown (Baker, 1980); NEW CALEDONIA: south-eastern New Caledonia, 70-301m (present study, new locality).

Remarks
Asteromorpha tenax is related to *A. capensis* in sharing polygonal plate-shaped external ossicles densely tessellated on aboral body while *A. rousseaui* and *A. koehleri* have two types of external ossicles on aboral body.

Asteromorpha tenax is also related to *A. koehleri* in sharing the same reproductive mode. Of the 16 examined specimens of *A. tenax*, 13 have six arms and the other three have three, four, and five arms. Eleven specimens with six arms and one specimen with four arms show conspicuous fission planes across their discs, suggesting fissiparous reproduction of this species. *A. rousseaui* and *A. capensis* are not fissiparous.

Asteromorpha tenax is distinguished from the other three species (*A. capensis*, *A. rousseaui*, and *A. koehleri*) in having large tubercles on the radial shields. One to four diagnostic large tubercles are present on the radial shields of 12 of the 16 examined specimens, including specimens with / without fission planes. The other four specimens without the large tubercles have conspicuous fission planes and thus large tubercles may have been lost when their discs divided.

Asteromorpha tenax can also be distinguished from the other three species by having a uniformly white body colour (see *Colour* of *A. capensis*, *A. rousseaui* and *A. koehleri*).

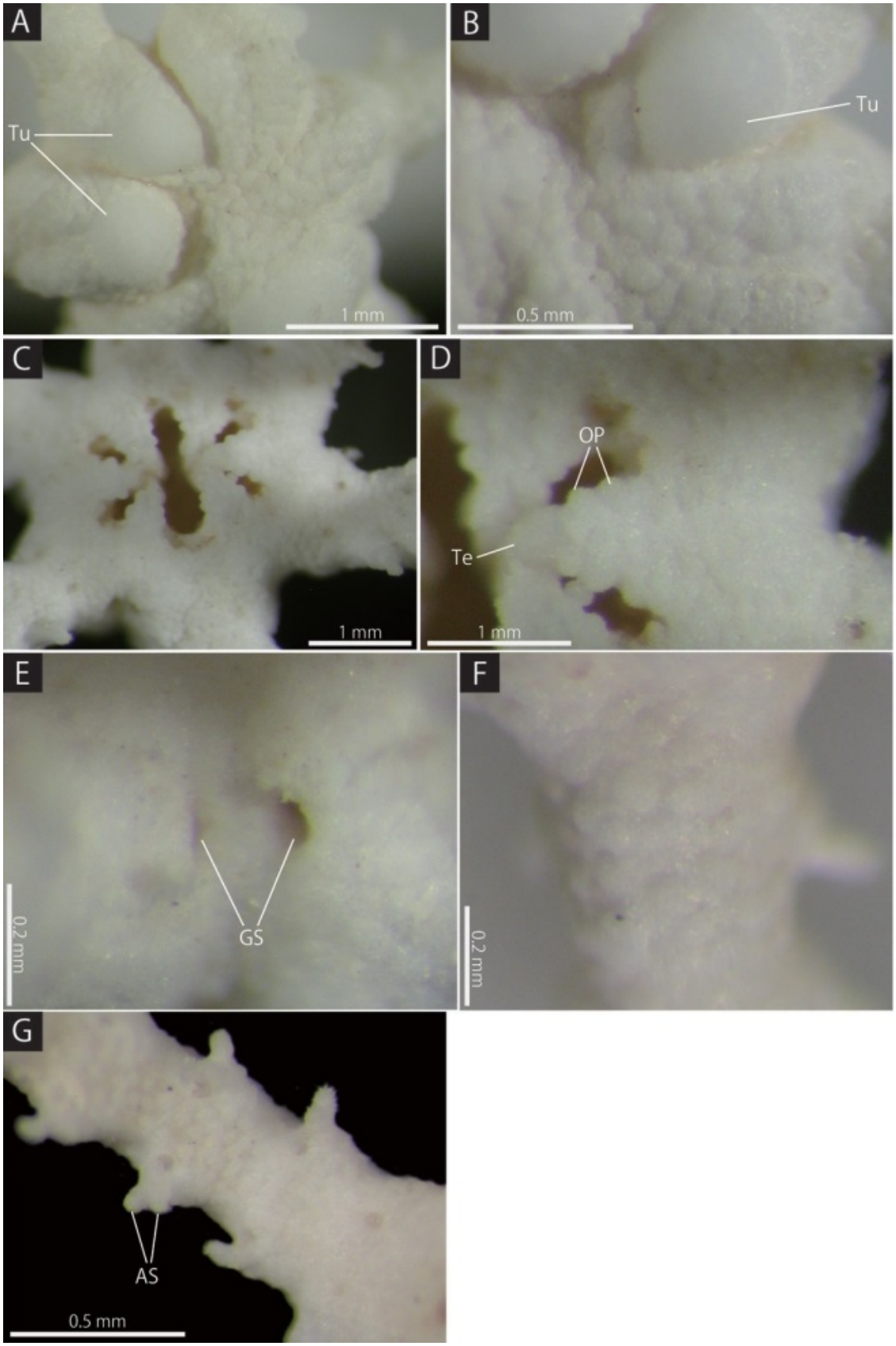

Figure 5.13. *Asteromorpha tenax* (MNHN IE-2013-4003): A, aboral disc and oral basal portion of arms; B, aboral periphery part of disc; C, oral disc and basal portion of arm; D, oral periphery part of disc and jaws; E, lateral interradial part of disc; F, aboral basal portion of the arms; G, oral basal portion of the arm. Abbreviations: AS: arm spine; GS: genital slit; OP: oral papillae; Te: teeth; Tu: tubercle.

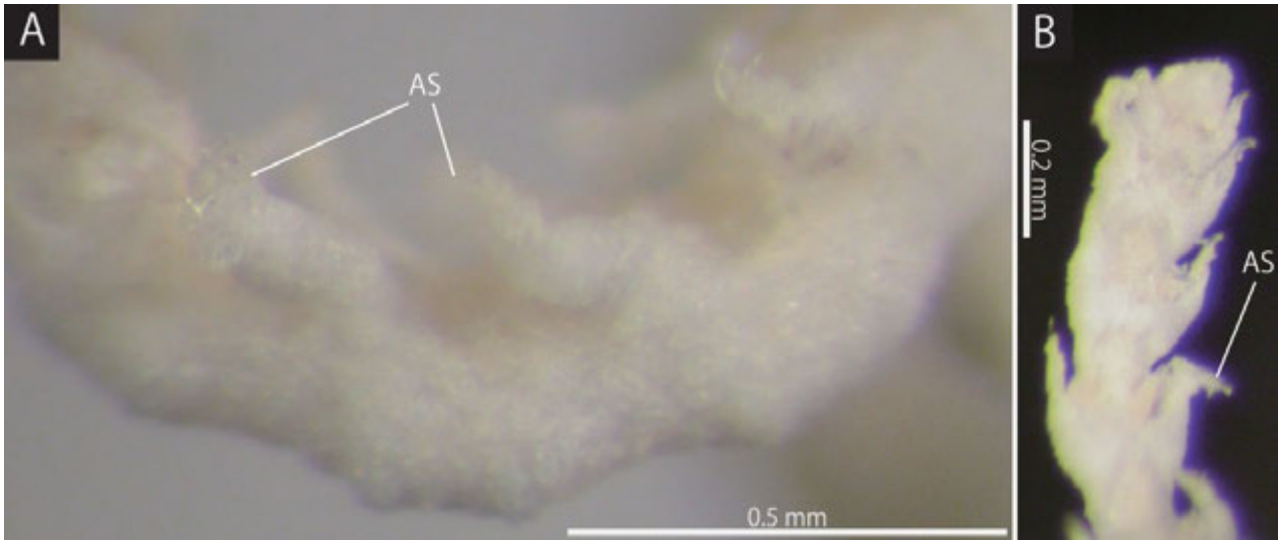

Figure 5.14. *Asteromorpha tenax* (MNHN IE-2013-4003): A, lateral distal portion of the arm; B, oral tip of the arm. Abbreviations. AS: arm spine.

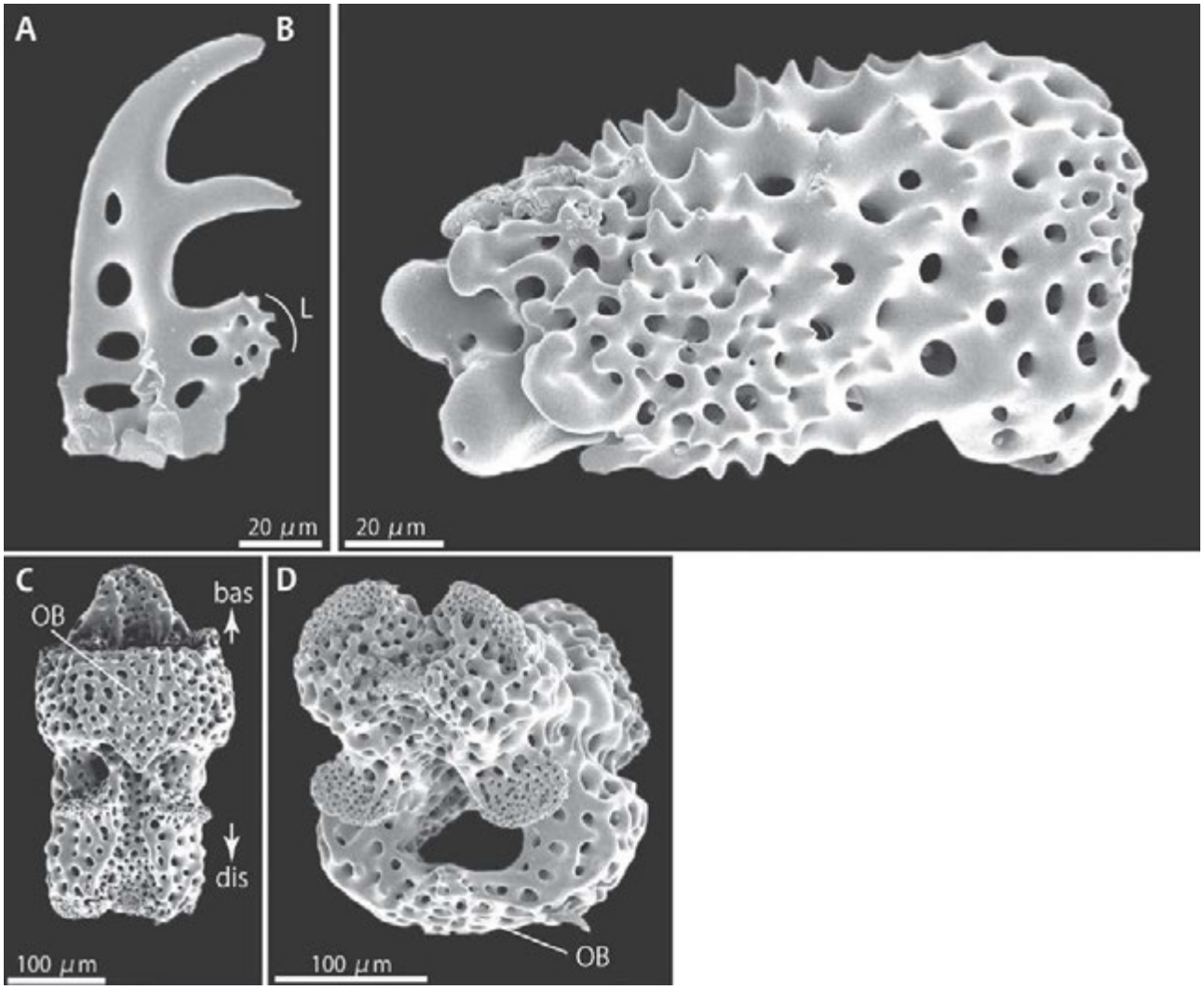

Figure 5.15. *Asteromorpha tenax* (MNHN IE-2013-4003), SEM photographs of internal ossicles: A, arm spine from middle portion of the arm; B, lateral arm plate at middle portion of the arm, external view; C, D, vertebrae at distal portion of the arm, oral view (C), distal view (D). Arrows indicate orientations: bas: basal side; dis: distal side. Abbreviations: L: lamina; OB: oral bridge.

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Chapter 6: Field Guide to the Brittle stars (Echinodermata: Ophiuroidea) of South Africa.

INTRODUCTION

Brittle stars (ophiuroids) are one of five extant classes of the phylum Echinodermata and have a fossil record dating back some 500 million years to the Early Ordovician. Today they remain diverse and widespread, with over 260 described genera and 2140 species (Stöhr *et al.*, 2016), more than any other class of echinoderm, and occupy all marine habitats from the intertidal shore to the abyss. In southern Africa, the ophiuroid fauna has been studied extensively by a number of authors (Clark, 1923; Mortensen, 1933c; Balinsky, 1957; Clark and Courtman-Stock, 1976) and is relatively well-known. Although Clark and Courtman-Stock (1976) reviewed all the existing species of echinoderms (apart from the holothuroids) known from southern Africa up to that time, their monograph is not easy to follow by non-experts or naturalists. There have also been a substantial number of changes in nomenclature, additions to the fauna and extensions to the known ranges of species since 1976, all of which necessitate a new guide to regional species.

The following guide is designed to be comprehensive, fully illustrated, and easy to use for naturalists and biologists alike and to supersede the Ophiuroidea chapter in Clark and Courtman-Stock (1976). All South African species discovered over the last 39 years, as well as new distributional records to the region, are included. The guide includes a taxonomic key, plus key references, distribution maps, diagnoses, ecological information and photographs or illustrations for each individual species. Where possible, type material was examined (as indicated). The morphological characters and terminology used are detailed in Chapter 1 and in the glossary (Appendix A).

MATERIALS AND METHODS

The study area was limited to the political boundaries and EEZ of mainland South Africa (Figure 6.1) and in this respect differs from Clark and Courtman-Stock (1976) who included records from a wider southern African region. A total of 136 reported Ophiuroidea species are thus included, as listed in the checklist of South African Ophiuroidea (Appendix B).

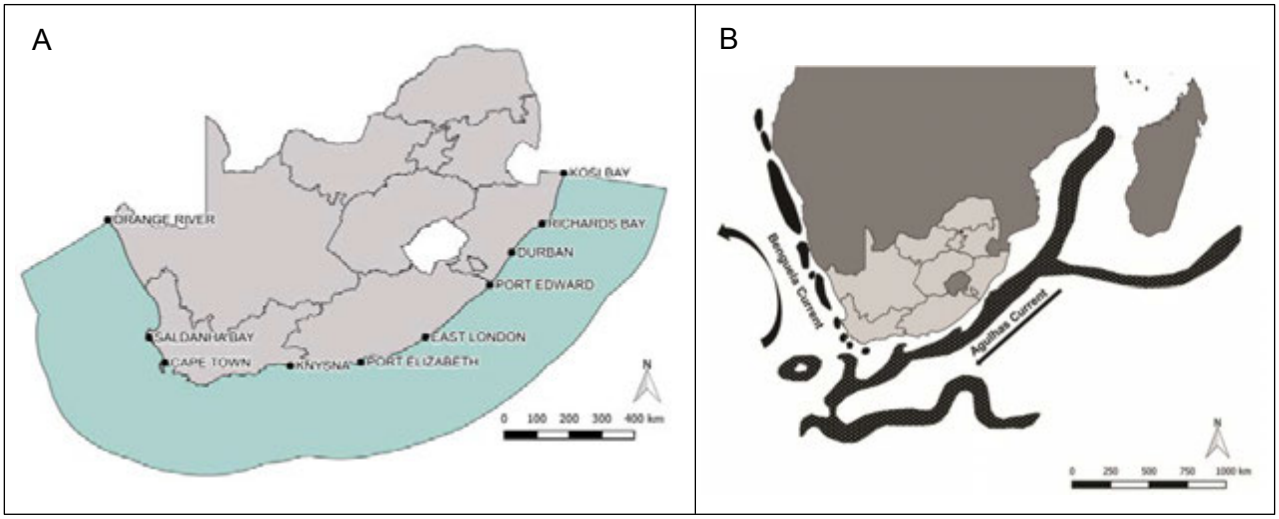

Figure 6.1. A) Exclusive Economic Zone (EEZ) of mainland South Africa showing provincial boundaries and major coastal towns; B) major oceanographic features (adapted from Lutjeharms *et al.*, 2001). NC: Northern Cape; WC: Western Cape; EC: Eastern Cape; KZN: KwaZulu-Natal.

The species accounts reported on here are drawn from a number of sources. These include:

i) Published literature on South African Ophiuroidea (Lyman, 1878; Lyman, 1882; Bell, 1905; Clark, 1923; Mortensen, 1925; Mortensen, 1933c; Clark, A.M., 1952; Clark and Rowe, 1971; Clark, 1974; Clark and Courtman-Stock, 1976; Clark, 1977; Madsen, 1977; Cherbonnier and Guille, 1978; Thandar, 1989; Olbers and Samyn, 2012; Milne, 2012; Mbongwa, 2013; Olbers *et al.*, 2014; Olbers *et al.*, 2015).
ii) Large expedition or survey data (*Valdivia*, *Pickle*, *Challenger*, *Pieter Faure*, *Meiring Naude*, *Anton Bruun, Safari* and the *Africana*).
iii) South African institutional collections (JLB Smith Institute Field Expedition, Natal Museum Dredging Programme, South African Fisheries Surveys, Ezemvelo KZN Wildlife echinoderm collection and the University of Cape Town Ecological Surveys); and
iv) International museum's collections (Australian Museum, Sydney, Australia (AM); Natural History Museum, Genève, Switzerland (GMNH / MHNG); Museum of Comparative Zoology, Harvard University, Massachusetts, United States of America (MCZ); National Natural History Museum, Paris, France (MNHN); National Museum Victoria, Australia (MV); Naturalis Biodiversity Centre, Leiden, Netherlands (incorporating ZMA: Zoological Museum Amsterdam and RMNH: National Museum of Natural History (Naturalis); Natural History Museum, London, United Kingdom (NHMUK); Royal Belgian Institute of Natural Sciences, Brussels, Belgium (RBINS); Royal Museum for Central Africa, Tervuren, Belgium (RMCA); Swedish Museum of Natural History, Stockholm, Sweden (SMNH); Smithsonian Institution, National Museum of Natural History, Washington, D.C., United States of America (USNM); Museum of Natural History at the University of Berlin, Germany (ZMB); Natural History Museum of Denmark, Copenhagen, Denmark (ZMUC); and Zoological State Collection Munich, Munich, Germany (ZSM)).

The majority of new records and data were sourced from previously unidentified specimens deposited in the Iziko South African Museum (South Africa) collection, while additional records were obtained from photographic evidence sourced from the South African National Biodiversity Institute (SANBI) iSpot programme, and the University of Cape Town Animal Demographic Unit EchinoMAP programme.

Taxa are arranged according to their currently known classification, as given by Stöhr *et al.* (2016) in the World Ophiuroid Database linked to the World Register of Marine Species (WoRMS). Species are presented under the binomen as considered valid by Stöhr *et al.* (2016).

A comprehensive diagnosis is given and where possible, type material, distribution (including maps), ecology and additional notes are also reported. In addition, where specimens were available, these were photographed. Appendix C lists the accession numbers and available information of the photographed / illustrated specimens.

CHECKLIST TO SOUTH AFRICAN OPHIUROIDEA

A checklist of all species recorded for South Africa is presented in Appendix B. The table indicates which species are endemic, which have had significant range extensions and which are recorded as new to the South African fauna as a result of this study. In addition, those species which have had changes to their nomenclature since Clark and Courtman-Stock (1976), are also indicated.

KEY TO SOUTH AFRICAN OPHIUROIDEA

This dichotomous key requires a basic knowledge of ophiuroid taxonomy, which can be gained using this guide. Each pair of statements provides two alternate options with the statement closest to the

character of the specimen in question being selected. A reference figure is provided for each species. It should be noted that this key cannot reliably be used for species found outside South Africa.

1 Disc and body covered in thick skin....2
- Disc and body not covered, if covered then skin is thin....21
2 Arms always simple....3
- Arms branched....9
3 Skin concealing radial shields....16
- Skin covered but radial shields distinct....4
4 Radial shields narrow or bar-like....5
- Radial shields broad, may be tapering....***Asteromorpha capensis* (Fig. 6.5)**
5 Disc and radial shields naked....***Asteronyx loveni* (Fig. 6.11)**
- Disc and radial shields with armament....6
6 Disc or radial shields armed with low tubercles / granules / warts....7
- Disc or radial shields armed with stumps....8
7 Body covered in coarse and fine granules intermixed....***Astrothorax waitei* (Fig. 6.25)**
- Body covered in low minute granules....***Asteroschema salix* (Fig. 6.3)**
8 One pair of stumps per arm segment....***Astroceras spinigerum* (Fig. 6.9)**
- More than two stumps per arm segment....***Asterostegus tuberculatus* (Fig. 6.7)**
9 Madreporites, five, deep in interradius….....***Astroglymma* cf. *sculptum* (Fig. 6.23)**
- Madreporites less than five, indistinct....10
10 Oral papillae in distal notches....11
- Oral papillae absent in distal notches....13
11 Dorsal arms armed with tubercles....12
- Dorsal arms smooth, flat platelets....***Astrocladus africanus* (Fig. 6.15)**
12 Arm armament fine and smooth....***Astrodendrum capensis* (Fig. 6.21)**
- Arm armament distinct, variable in size surrounded by dark rings....***Astrocladus euryale* (Fig. 6.17)**
13 Arm spines begin after at least second fork....14
- Arm spines begin before first fork....15
14 Belt of hooks complete from fifth fork....***Astrocladus hirtus* (Fig. 6.19)**
- Belt of hooks complete from third fork....***Astroboa nuda* (Fig. 6.13)**
15 Genital papillae in series with papillae of oral area; no gap in tubercles between radial shields and disc…….....***Gorgonocephalus chilensis* (Fig. 6.27)**
- Genital papillae randomly spaced / placed, distinct gaps in tubercles between radial shields and disc....***Gorgonocephalus pustulatum* (Fig. 6.29)**
16 Oral papillae broad, serrated, flattened....17
- Oral papillae spiniform....19
17 Arm spines slender and serrated....18
- Arm spines long, with lowermost club or cigar-shaped....20
18 Two arm spines on segments 3 - 4....***Ophiomyxa australis* (Fig. 6.31)**
- One arm spine on segments 3 - 4....***Ophiomyxa vivipara capensis* (Fig. 6.37)**
19 Second oral tentacle pore outside oral slit....***Ophioscolex inermis* (Fig. 6.41)**
Second oral tentacle pore inside oral slit....***Ophiolycus dentatus* (Fig. 6.39)**
20 Dorsal arm plates fragmented....***Ophiomyxa tenuispina* (Fig. 6.35)**
- Dorsal arm plates not fragmented....***Ophiomyxa bengalensis* (Fig. 6.33)**
21 Single, pointed apical papillae....22
- No apical papillae, or if present then not pointed....37
22 Radial shields not naked, or only partly naked….....23

- Radial shields naked.....29
23 Jaws granulated.....*Ophiolimna perfida* **(Fig. 6.217)**
- Jaws not granulated.....24
24 Two tentacle scales basally.....25
- One tentacle scale basally.....26
25 Disc covered in dense spines only.....*Ophiotreta matura* **(Fig. 6.239)**
- Disc covered in granules, sometimes with interspersed spines.....*Ophiotreta durbanensis* **(Fig. 6.237)**
26 Arms monoliliform.....*Ophiacantha baccata* **(Fig. 6.209)**
- Arms not monoliliform.....27
27 Ventral arm plates fan-shaped.....28
- Ventral arm plates pentagonal, distal side straight.....*Ophiacantha nerthepsila* **(Fig. 6.211)**
28 Ventral and lateral arm plates with concentric striations.....*Ophiacantha scutigera* **(Fig. 6.213)**
- All arm plates with concentric striations.....*Ophiacantha striolata* **(Fig. 6.215)**
29 Dorsal arm plates contiguous basally.....*Ophiopthalmus relictus* **(Fig. 6.223)**
- Dorsal arm plates not contiguous basally.....30
30 Ventral interradial areas with no armament.....33
- Ventral interradial areas with armament (granules, stumps and / or spines).....31
31 Oral shields triangular or heart-shaped.....32
- Oral shields diamond-shaped, wider than long.....*Ophiothamnus remotus* **(Fig. 6.231)**
32 Arm spines exceeding segment length, jaws sunken..*Ophiomitrella corynephora* **(Fig. 6.219)**
- Arm spines not exceeding segment length, jaws flat.....*Ophiomitrella hamata* **(Fig. 6.221)**
33 Arm spines four, smooth.....34
- Arm spines seven, spiny, lowermost shortest.....36
34 Six arms.....*Ophioplinthaca sexradia* **(Fig. 6.229)**
- Five arms.....35
35 Oral shields spearhead-shaped, with distinct lobe, much wider than long; tentacle scales 5-6, spinose; dorsal arm plates triangular, as long as wide, not contiguous.....*Ophiotoma* **cf.** *gracilis* **(Fig. 6.235)**
- Oral shields D-shaped with slight lobe; tentacle scales needle-like or round, small if not absent; dorsal arm plates triangular to bell-shaped, twice as wide as long.....*Ophiotoma* **cf.** *alberti* **(Fig. 6.233)**
36 Disc margin may have scattered spines; radial shields only just contiguous distally if at all; tentacle scales large, flat, pointed.....*Ophioplinthaca papillosa* **(Fig. 6.225)**
- Disc margin spines absent; radial shields not contiguous; tentacle scales large, thick and pointed.....*Ophioplithaca rudis* **(Fig. 6.227)**
37 Pair of symmetrical papillae at apex of each jaw.....40
- Multiple or single apical papillae, rarely two, but if so papillae asymmetrical.....38
38 Oral papillae fused, forming a serrated flange.....*Ophiodaphne scripta* **(Fig. 6.125)**
- Oral papillae not fused.....39
39 Apical papillae symmetrical, offset laterally.....*Amphilepis scutata* **(Fig. 6.81)**
- Apical papillae may be present, if a pair then asymmetrical.....61
40 Basal arm spines form a flange.....41
- Basal arm spines do not form a flange.....42
41 All segments which border genital slits have fused arm spines (except lowest arm spine) forming curved flange on each side of arm.....*Amphilimna cribriformis* **(Fig. 6.83)**
- On first segment, two lowest arm spines each side of arm unmodified, but upper spines flattened and fused, forming curved flange which borders genital slits.....*Amphilimna valida* **(Fig. 6.85)**

42 Four oral papillae.....43
- One to three oral papillae.....46
43 Four oral papillae with a gap between first infradental papillae and second oral papillae revealing second oral tentacle scale, which is in series.....***Amphioplus* (*Amphioplus*) *pectinatus* (Fig. 6.87)**
- Four oral papillae in series, third papilla enlarged and no distinct oral tentacle scale.....44
44 Disc margin with no armament.....***Amphioplus* (*Lymanella*) *integer* (Fig. 6.93)**
- Disc margin vertical with small spines or projections.....45
45 Thirteen disc scales between radial shields.....***Amphioplus* (*Lymanella*) *furcatus* (Fig. 6.91)**
- 9-11 disc scales between radial shields.....***Amphioplus* (*Lymanella*) *depressus* (Fig. 6.89)**
46 Three oral papillae with a single oral tentacle scale in series, second oral papilla on lower level than other two, third papilla large and broad.....***Amphioplus* (*Unioplus*) falcatus (Fig. 6.95)**
- Three oral papillae, outermost very broad and opercular.....47
47 Radial shields narrow, bar-like.....48
- Radial shields broad, D-shaped; may be missing disc 'lid'.....49
48 Three arm spines.....***Amphipholis similis* (Fig. 6.97)**
- Four arm spines.....***Amphipholis squamata* (Fig. 6.99)**
49 Ventral disc partially skin covered, with incomplete scaling.....50
- Ventral disc fully scaled, no skin.....51
50 Six or more arm spines proximally, middle spine with glassy hook; distal oral papillae broad and semi-circular.....***Amphiura* (*Amphiura*) *uncinata* (Fig. 6.123)**
- Four or five arm spines proximally, none hooked; distal oral papillae elliptical leaf-like.....***Amphiura* (*Amphiura*) *albella* (Fig. 6.105)**
51 Two tentacle scales.....52
- Tentacle scale single or absent.....55
52 Tentacles scales moderate to large in size.....53
Tentacle scales small in size or absent 54
53 Tentacle scales very large, ventral arm plates broad pentagonal.....***Amphipholis strata* (Fig. 6.101)**
- Tentacle scales moderate, ventral arm plates truncated pentagonal.....***Amphiura* (*Amphiura*) *acutisquama* (Fig. 6.103)**
54 Disc scales coarse and thick; arm spines blunt and flattened.....***Amphiura* (*Amphiura*) *incana* (Fig. 6.115)**
- Disc scales moderately coarse; arm spines pointed, some with terminal hook.....***Amphiura* (*Amphiura*) *otteri* (Fig. 6.119)**
55 One distal oral papilla, tentacle scales absent or rudimentary.....***Amphiura* (*Amphiura*) *atlantica* (Fig. 6.109)**
- One distal oral papilla, single tentacle scale.....56
56 Tentacle scale oval.....57
Tentacle scale pointed, spiniform.....58
57 Radial shields tapering proximally, may be only just separated distally.....***Amphiura* (*Amphiura*) *grandisquama natalensis* (Fig. 6.113)**
Radial shields contiguous for at least half-length.....***Ophionephthys lowelli* (Fig. 6.127)**
58 At least one arm spine flattened.....59
Arm spines stout, blunt, tapering.....***Amphiura* (*Amphiura*) *angularis* (Fig. 6.107)**
59 Arm spines flattened, second lowest spine conspicuously curved; no more than five arm spines.....***Amphiura* (*Amphiura*) *simonsi* (Fig. 6.121)**
- Arm spines flattened, more than five arm spines.....60

60 Radial shields long, narrow, well-separated and almost parallel, more than one-third disc radius, six arm spines.....***Amphiura* (*Amphiura*) *linearis* (Fig. 6.117)**

- Radial shields longer than wide, diverging and tapering distally, contiguous at distal ends, less than half disc radius; seven arm spines.....***Amphiura* (*Amphiura*) *capensis* (Fig. 6.111)**

61 Teeth broad and square-tipped, single apical papilla or reduced tooth.....62

- Teeth broad and square-tipped, rounded or conical, one or many papillae.....69

62 Disc scaling overlapping and armament absent.....***Histampica duplicata* (Fig. 6.129)**

- Disc with coarse scaling and armament present.....63

63 One distal oral papillae.....64

- Two or three distal oral papillae.....65

64 Oral shields almost circular, as long as wide; fissiparous (usually six arms).....***Ophiactis plana* (Fig. 6.139)**

- Oral shields diamond-shaped, five arms, not fissiparous, Radial shields contiguous distally, ventral arm plates fan-shaped.....***Ophiactis carnea* (Fig. 6.133)**

65 Up to four arm spines.....66

- More than four arm spines, usually six.....67

66 Dorsal arm plates diamond-shaped, twice as wide as long, not contiguous distally; not fissiparous.....***Ophiactis abyssicola* (Fig. 6.131)**

- Dorsal arm plates narrow fan-shaped, broadly in contact, longer than wide; fissiparous.....***Ophiactis nidarosiensis* (Fig. 6.135)**

67 Dorsal arm plates oval, becoming elliptical, rounded distally with median lobe emphasized by two dark spots after first two to three segments; fissiparous, up to seven arms.....***Ophiactis savignyi* (Fig. 6.141)**

- Dorsal arm plates oval, becoming elliptical, arms marbled with dark spots; not fissiparous, five long arms.....***Ophiactis* cf. *picteti* (Fig. 6.137)**

68 No oral papillae, each jaw with cluster of apical dental papillae.....69

- Oral papillae present on sides of jaws, apically either a cluster of dental papillae or one or a few larger oral papillae.....84

69 Disc and arms covered in skin, sometimes with granules.....70

Disc scales and arm plates distinct, unless covered in armament such as spines or stumps.....73

70 Arms mostly flexible horizontally; dorsal and ventral arm plates present beneath skin, but dorsal arm plates may be fragmented; longest arm spines easily exceeding segment length.....71

- Arms flexible dorso-ventrally; dorsal and ventral arm plates rudimentary / absent; arm spines short, barely exceeding single segment length.....72

71 Dorsal arm plates mostly entire; seven arm spines.....***Ophiogymna fulgens* (Fig. 6.189)**

- Dorsal arm plates fragmented; eight arm spines.....***Ophiogymna capensis* (Fig. 6.187)**

72 Fissiparous, usually six arms; armament on disc margin usually more granuliform than spinose.....***Ophiothela danae* (Fig. 6.191)**

- Not fissiparous, usually five arms; disc armament usually includes marginal spines.....***Ophiothela venusta* (Fig. 6.193)**

73 Radial shields naked, very large, taking up most of dorsal side; narrow interradial areas and centre of disc scales covered in granules.....***Ophiocnemis marmorata* (Fig. 6.185)**

- Radial shields may or may not be covered in armament, but usually smaller in area than remainder of disc, which may be covered in spines or stumps.....74

74 Dorsal arm plates wide and broadly contiguous, arms long, 8-20 times D.D.....75

- Dorsal arm plates less than twice as long as wide, narrowly in contact, arm length moderate, 4-8 times D.D……..76

75 Radial shields densely covered in stumps or spines 77

- Radial shields naked, or mostly so.....78

76 Disc covered in stumps; colour grey and dark blue or purple, both dorsally and ventrally; dorsal arms with a longitudinal light stripe bordered by two dark blue lines, ventral arms with similar stripe but less conspicuous, radial shields variegated with blue.....***Macrophiothrix hirsuta cheneyi*** **(Fig. 6.179)**

- Only disc margin with stumps; colour pink, purple with patterns on disc, arms banded every three to four segments. Radial shields reddish, sometimes with blue patches, distal edge outlined with white, no longitudinal line down arms, arm spines with long thorn near tip.....***Macrophiothrix propinqua*** **(Fig. 6.183)**

77 Ventral armament not reaching proximal edges of genital slits; dorsal side of disc greyish with more or less conspicuous dark pink spots, ventrally lighter and less spots. Arms banded purple, pink or red with white dorsally and lighter ventrally, with two to three arm segments between bands; may have white longitudinal band from *c.* half way down arms.....***Macrophiothrix demessa*** **(Fig. 6.177)**

- Ventral armament reaching edges of genital slits; disc dorsally and ventrally blue or purple with blue or purple spots and blotches, radial shields spotted, ventrally similar but lighter, arms banded with white, or spotted with purple……...***Macrophiothrix longipeda*** **(Fig. 6.181)**

78 Arms marked with one or more longitudinal lines running down arms.....79

- Arms patterned, but not with longitudinal lines.....81

79 Arms with either faint white longitudinal line, or light line with two darker lines either side.....80

- Arms with single thin dark longitudinal line along length of arm both dorsally and ventrally, dorsal arm plates with some lateral whitish patches.....
.....***Ophiothrix*** **(*Acanthophiothrix*)** ***purpurea*** **(Fig. 6.197)**

80 Dorsal arm plates hexagonal or fan-shaped, wider than long; colour brownish green with yellow or white line bordered by two dark lines of dark purple or green, longitudinal white stripe along entire length of arm with two darker lines either side.....***Ophiothrix*** **(*Acanthophiothrix*)** ***proteus*** **(Fig. 6.195)**

- Dorsal arm plates fan, rhomboidal or diamond-shaped, distal side strongly convex, equally wide as long or slightly wider; colour grey, red, pink, arms similar, light white longitudinal line, sometimes bordered by pink or red stripes.....***Ophiothrix*** **(*Ophiothrix*)** ***aristulata*** **(Fig. 6.199)**

81 Dorsal arm plates armed with single short rugose stump between successive dorsal arm plates.....***Ophiothrix*** **(*Ophiothrix*)** ***echinotecta*** **(Fig. 6.201)**

- No stump between successive dorsal arm plates.....82

82 Disc and radial shields patterned with dark purple lines and pinkish patches with adradial edges of radial shields accentuated with dark lines, arms not banded.....***Ophiothrix*** **(*Ophiothrix*)** ***foveolata*** **(Fig. 6.203)**

- No linear patterns on disc or radial shields, arms banded and often with dots associated with dorsal arm plates.....83

83 Spines and stumps intermixed on disc.....***Ophiothrix fragilis*** **(Fig. 6.205)**

- Spines and stumps not intermixed on disc.....***Ophiothrix fragilis*** **var. *triglochis*** **(Fig. 6.207)**

84 Both oral and dental papillae present.....85

- Only oral papillae present, usually only single apical papillae below teeth, but sometimes two or three.....97

85 Two tentacle scales, beyond basally tentacle scale/s elongated or sword-like, aligned obliquely across ventral arm plate forming a cross with corresponding tentacle scale.....86

- One or two tentacle scales, both oval.....87
86 Only inner tentacle scale spiniform, distal oral papillae small, papilliform with rounded tips…….....***Ophiopsila seminuda*** **(Fig. 6.167)**
- Both tentacle scales spiniform, distal oral papillae also spiniform.....***Ophiopsila bispinosa*** **(Fig. 6.165)**
87 Five arms, not fissiparous.....88
- Six arms, fissiparous.....***Ophiocomella sexradia*** **(Fig. 6.159)**
88 Disc covered at least dorsally with dense granules.....89
- Disc smooth or with granules and spines, upper arm spines club / clavate in shape.....96
89 One tentacle scale.....***Ophiocoma valenciae*** **(Fig. 6.157)**
- Two tentacle scales.....90
90 On one to three consecutive segments at about one-third of length of arm, uppermost arm spine enlarged or clavate.....***Ophiocoma pusilla*** **(Fig. 6.153)**
- Uppermost arm spines one-third of the length along arm not enlarged.....91
91 Disc dark with radiating golden lines….....***Ophiocoma pica*** **(Fig. 6.151)**
- Disc light and mottled, uniformly dark, or with spots or speckles.....92
92 Disc light with patterns / mottles of greens, whites, yellows, similar number of arm spines on each arm segment…….....***Ophiocoma*** **(*Breviturma*)** ***brevipes*** **(Fig. 6.143)**
- Disc brown / dark in colour.....93
93 Disc with speckles / spots.....94
- Disc uniformly dark above and below, tube feet red, white when preserved.....***Ophiocoma erinaceus*** **(Fig. 6.149)**
94 Arm spine annulation very faint, if at all.....***Ophiocoma*** **(*Breviturma*)** ***dentata*** **(Fig. 6.145)**
- Arm spine annulation strong / broken if present.....95
95 Colour greyish brown dorsally and ventrally, either with fine black reticulating lines, white-ringed black spots, or speckled with light spots; two or three tentacle scales along arms .....***Ophiocoma*** **(*Breviturma*)** ***doederleini*** **(Fig. 6.147)**
- Colour broken or uniform brown; two oval tentacle scales.....***Ophiocoma scolopendrina*** **(Fig. 6.155)**
96 Arm spines 3-4, spines annulated; disc uniformly dark.....***Ophiomastix koehleri*** **(Fig. 6.161)**
- Arm spines 2-4, dark longitudinal lines on spines, disc light brown with radiating lines.....***Ophiomastix venosa*** **(Fig. 6.163)**
96 Arms inserted below disc, arm spines rarely much shorter than segment, projecting sideways from arm, pair of supplementary dorsal arm plates present.....98
- Arms fused to disc edge, arm spines usually shorter than segment and usually appressed to arm, but may be long and outstanding, supplementary dorsal arm plates only present if arm spines short and appressed to arms.....101
98 Genital papillae absent.....99
- Genital papillae present.....100
99 Colour pattern reticulated with a well-marked ‘V’ or ‘Y’ opposite base of each arm; supplementary dorsal arm plates triangular, length of dorsal arm plate becoming smaller distally.....***Ophionereis dubia dubia*** **(Fig. 6.171)**
- Disc white with large reddish-brown dense spot or star in middle of disc; supplementary dorsal arm plates large.....***Ophionereis vivipara*** **(Fig. 6.175)**
100 Supplementary dorsal arm plates small and only well-developed on proximal part of arms; disc scales coarse, subequal.....***Ophionereis australis*** **(Fig. 6.169)**
- Supplementary arm plates well-developed for most of arm, interradial disc scales distinctly smaller than radial and marginal scales.....***Ophionereis porrecta*** **(Fig. 6.173)**

101 Disc densely granulated, including jaws and sometimes including oral shields and adoral shields.....102
- Disc scales naked and most often distinct.....113
102 Oral shields mostly covered in granules.....103
- Oral shields naked.....106
103 One tentacle scale.....104
- Two or three tentacle scales.....105
104 Teeth wide with hyaline edges; disc concealed by granules, no granules on basal arm segments.....***Ophioconis cupida*** **(Fig. 6.245)**
- Teeth pointed, no hyaline edges; disc concealed by granules, granules extending onto basal arm segments.....***Cryptopelta aster*** **(Fig. 6.241)**
105 Disc covered in granulation and spinelets; arm spines all shorter than one segment length; tentacle scales two proximally, one along most of arm.....***Ophiochaeta hirsuta*** **(Fig. 6.243)**
- Disc covered in granulation; arm spines less than half segment length; tentacle scales three basally, two distally.....***Ophiodyscrita acosmeta*** **(Fig. 6.247)**
106 Genital slits single (two in each interradius).....107
- Genital slits two (four in each interradius).....***Ophioderma wahlbergi*** **(Fig. 6.263)**
107 Radial shields naked.....108
- Radial shields covered in armament.....111
108 Oral shields and supplementary oral shields naked; radial shields moderate to small.....109
- Oral shields and supplementary oral shields concealed by granules, easily rubbed off; radial shields very large.....***Ophiochasma nitida*** **(Fig. 6.261)**
109 Arm spines same length as segment except lowermost, which is twice as long as segment; colour bright red.....***Ophiarachnella septemspinosa*** **(Fig. 6.259)**
- Arm spines short, no longer than half segment length, colour combination of browns, greens and / or whites.....110
110 Arm spines conical, with lowermost shorter than half segment length, colour irregular patterns of browns, sometimes with irregular dark spot or blotch in middle of disc.....***Ophiarachnella capensis*** **(Fig. 6.255)**
- Arm spines tapering, all half segment length; colour greens, greys and whites.....***Ophiarachnella gorgonia*** **(Fig. 6.257)**
111 Arm spines long and flaring, all exceeding segment length.....***Ophiarachna affinis*** **(Fig. 6.253)**
- Arm spine length never exceeding segment length.....112
112 Marginal scales enlarged, few but large, supplementary oral shields covered in granules.....***Ophiopeza fallax fallax*** **(Fig. 6.249)**
- Marginal scales enlarged, many but small, supplementary oral shields not covered by granules.....***Ophiopeza spinosa*** **(Fig. 6.251)**
113 Oral slits generally tightly closed, oral papillae not in continuous series with oral tentacle scales, no true tentacle scales, disc scales thick.....114
- Oral slits may be closed, oral papillae in continuous series with oral tentacle scales, disc scaling usually distinct, but not necessarily thick.....118
114 Disc scales smooth or tumid, low granules, oral papillae not fused.....115
Disc scales smooth, oral papillae fused.....116
115 Dorsal interradial area covered by a single scale, many scales of various sizes on remainder of dorsal disc, low and tumid tubercles present on disc.....***Ophiomusium lymani*** **(Fig. 6.271)**
- Dorsal interradial area with many scales, disc scales naked.....117
116 Dorsal interradial area covered by a single scale, but remainder of disc with many scales of various sizes, three arm spines, one separated from other two.....***Anophiura simplex*** **(Fig. 6.265)**

- Dorsal interradial margin covered by a single scale with remainder of dorsal disc scales few and of similar size; three arm spines, equally spaced.....***Aspidophiura corone*** **(Fig. 6.267)**

117 Disc scales surrounded by smaller scales both dorsally and ventrally, colour pink to brown, irregularly marbled with grey, white or silver patches.....***Ophiolepis cincta cincta*** **(Fig. 6.269)**

- Disc scales naked, imbricating, colour dark green or grey with irregular patterns and patches on dorsal disc conforming to interradial areas.....***Ophioplocus imbricatus*** **(Fig. 6.273)**

118 Disc extending into flat pentagon, lateral arm plates extremely modified, interradial edges straight fringed by modified arm spines, free arm segments very reduced.....***Astrophiura permira*** **(Fig. 6.53)**

- Disc not extending beyond normal limits, no modification to lateral arm plates or arm spines, free arm segments not reduced.....119

119 Disc scaled, granules at least on disc margin or on jaws.....120

- Disc scaled, granules absent.....122

120 Oral shields huge, reaching into ventral interradial area, disc with granules and jaws with scattered granules.....***Ophiopallas paradoxa*** **(Fig. 6.47)**

- Oral shields not extending into interradial area, disc margin with scattered granules, usually extending onto radial shields, no granules on jaws.....121

121 Arm spines three, longest spine as long as ventral arm plate, but others shorter than segment; bristles present on lateral arm plates.....***Ophiernus vallincola*** **(Fig. 6.45)**

- Arm spines four, shorter than segment, decreasing distally; no bristles on lateral arm plates .....***Ophiernus quadrispinus*** **(Fig. 6.43)**

122 Single tentacle scale, tentacle pores stopping abruptly after first 2-5 arm segments; oral papillae two, fused each side of triangular apical papillae.....***Ophiomisidium pulchellum*** **(Fig. 6.61)**

- One or more tentacle scales on basal pores, but often only one along arms; oral papillae three or more, not fused.....123

123 Oral shield distal lobe not well-developed or enlarged; three (*Ophiura kinbergi* only) or five or more tentacle scales on second oral pore.....128

- Oral shield distal lobe well-developed; one to three tentacle scales on second oral pore if present.....124

124 Arm spines short, none more than one-third segment length.....125

- Arm spines with at least one exceeding segment length.....126

125 Dorsal arm plates fan-shaped with rounded distal edge, contiguous, up to six arm spines, subequal, short and blunt.....***Amphiophiura sculptilis*** **(Fig. 6.49)**

- Dorsal arm plates bell-shaped, twice as long as wide proximally, first 4-5 plates contiguous, arm spines no more than three, one spine (usually uppermost) becoming hooked.....***Amphiophiura trifolium*** **(Fig. 6.51)**

126 Three arm spines, uppermost spine exceeding segment length.....127

- Three arm spines, uppermost two spines exceeding segment length.....***Ophiocten affinis simulans*** **(Fig. 6.55)**

127 Uppermost spine usually thicker than other two spines……..……..…***Ophiocten hastatum*** **(Fig. 6.59)**

- Uppermost spine not thicker than other two spines.....***Ophiocten amitinum*** **(Fig. 6.57)**

128 Radial shields contiguous, double arm combs....***Ophiura* (*Dictenophiura*) *anoidea*** **(Fig. 6.69)**

- Radial shields not contiguous or only just touching; arm combs single.....129

129 Uppermost arm spines much longer and stouter than others, exceeding segment length, dorsal arm plates oval and small.....***Ophiura* (*Ophiura*) *trimeni*** **(Fig. 6.71)**

- Arm spines similar, longest spines not longer than segment.....130

130 Three arm spines, middle spine becoming upturned hook on distal segments; genital papillae squat and broad.....131
- Three arm spines, all similar, genital papillae small and tapering.....134
131 Disc scales large, few interstitial scales.....132
- Disc scales medium or small, many interstitial scales.....133
132 Arm combs separated radially by more than half width of first free arm segment, disc scales not convex and dorsal arm plates almost flat in profile and contiguous.....***Ophiura* (*Ophiuroglypha*) *costata costata* (Fig. 6.73)**
- Arm combs approximating mid-radially, larger disc and dorsal arm plates not contiguous, swollen and convex in side view.....***Ophiura* (*Ophiuroglypha*) *costata tumida* (Fig. 6.75)**
133 Arm combs present but not distinct, widely separated, papillae stout and short, disc scales small, many and irregular, accessory ventral arm plate present on basal segments.....***Ophiura* (*Ophiuroglypha*) *irrorata irrorata* (Fig. 6.77)**
- Arm combs not widely separated, distinct, papillae large, square; disc scales thick, medium-sized, irregular.....***Ophiura* (*Ophiuroglypha*) *schmidtotti* (Fig. 6.79)**
134 Deep hollows between basal ventral arm plates.....***Ophiura kinbergi* (Fig. 6.65)**
- No hollows between basal ventral arm plates.....135
135 Radial shields almost half disc radius, not widely separated, small spines on disc, small in size.....***Ophiura ljungmani* (Fig. 6.67)**
- Radial shields small, oval, partly covered by disc scales, widely separated, no disc spines, large in size.....***Ophiura flagellata* (Fig. 6.63)**

TAXONOMIC ACCOUNT

Phylum ECHINODERMATA Bruguiere, 1791 (ex Klein, 1734)

Class OPHIUROIDEA Gray, 1840

Order EURYALIDA Lamarck, 1816

Diagnosis *- adapted from Mortensen (1933e), Baker (1980), Smith et al. (1995), Martynov (2010), Okanishi et al. (2011a).*
Skin either granulated / tuberculated or naked, generally lacking definite scales or shields. Radial shields distinctive, long, narrow, armed or smooth and radiate from centre to edge of disc. Arms simple or branched (forked), able to coil. Dorsal arm plates lacking or appear superficial. Ventral arm plates generally reduced, sometimes contiguous. Lateral arm plates located on ventral side of arms. Arm spines generally short, often transformed into hooks or spines, may be club-like. Oral shields reduced or absent. Teeth stout and plate-like or spiniform. Madreporite present in interradius, not always conspicuous. Genital slits small, short. Gonads may or may not be restricted to disc. No tentacle scales present.

Superfamily Euryalidea Gray 1840

Family ASTEROSCHEMATIDAE Verrill, 1899

Diagnosis *- adapted from Verrill (1899b) and Clark and Courtman-Stock (1976).*
Arms simple, flexible dorso-ventrally, long or stout, coiled. Disc lobed, naked or armed with granules or tubercles. Radial shields narrow and elongated. Oral and adoral shields present, but covered in thick skin. Oral papillae small. Teeth large, several in single row. Dorsal arm plates poorly developed,

covered in naked or granulated skin. Ventral arm plates small. Lateral arm plates moderately large, bearing modified spines or tentacle scales. Genital slits short and close to outer disc margin.

Genus *Asteroschema* Oersted and Lütken, 1856

Diagnosis *- adapted from Oersted and Lütken (1856) and McKnight (2000).*
Disc covered in skin with embedded platelets or ossicles, being either granule-shaped, cone-shaped or both or polygonal and flat or plate-shaped. Radial shields covered by tubercles or naked distally. Arms simple with ability to coil. Lateral arm plates large, contiguous on ventral groove. Gonads extend into arms.

Asteroschema salix Lyman, 1879

Figs 6.2 and 6.3.

Asteroschema salix Lyman, 1879: 66-67, pl. 17, figs 466-469; Baker, 1980: 23-24; McKnight, 2000: 21, 22. pl. 6, fig. 7; Olbers *et al.*, 2015: 85, pl.1A, B.

Diagnosis *- adapted from Lyman (1879), McKnight (2000) and Olbers et al. (2015).*
D.D. up to 10mm. Disc round, indented interradially, lateral interradial surface almost vertical, body surface covered with skin covered platelets with rounded granules. Radial shields elongated, narrow, raised, covered in plates, converging and almost meeting at centre of disc. Oral shields absent, adoral shields indistinct. Jaws covered by minute granules. Teeth seven, broad, triangular, lowermost appearing to be paired. Genital slits short, wide. Arms five, slender, flexible dorso-ventrally, narrow, higher than wide. No arm spines from first pair of tentacle pores to segment 15, then two arm spines, one slightly smaller. Arm spines short, innermost longest and cigar-shaped, finely serrated. Colour in life pink.

Distribution and habitat
New Zealand (McKnight, 2000), South Africa: off Glenmore (KZN); depth range 341-1 800m.
Habitat: No habitat details recorded.

Remarks
Recorded as new record to South Africa by Olbers *et al.* (2015). Single specimen recorded off KZN south coast, previously only known from New Zealand and thus a noteworthy range extension into the Indian Ocean. According to Baker (1980), type locality is West of Raoul Island, Kermadecs, depth 1152m. Holotype is in the Natural History Museum, London (NHMUK 82.12.23.271B) but was not located.

Figure 6.2. Distribution of *Asteroschema salix* in South Africa.

Figure 6.3. Dorsal (left) and ventral (right) views of *Asteroschema salix* (SAMC A28143).

Family EURYALIDAE (Gray, 1840)

Diagnosis *- adapted from Gray (1840a), McKnight (2000) and Okanishi et al. (2011c).*
Disc moderately large. Arms simple or branched (forked), flexible dorso-ventrally. Skin tuberculated or naked. Vertebrae with ventral groove. Belts of hooks absent. Ventral arm plates small, sometimes absent. Arm spines modified into hooks distally. Teeth apically in a single row. Gonads extend into arms, usually basally.

Genus Asteromorpha **Lütken, 1869**

Diagnosis *- adapted from Lütken (1869) and Okanishi et al. (2013).*
Disc with skin covered ossicles, either plate-shaped (in full contact) or granule-shaped (partly in contact). Radial shields may have large domed tubercles. Teeth triangular or square. Oral papillae domed, granule-shaped. Ventral side of vertebrae with oral bridge. Lamina of distal arm spines smooth. Tentacle pores with two arm spines from fourth (rarely fifth) arm segment.

***Asteromorpha capensis* (Mortensen, 1925)**

Figs 6.4 and 6.5.

Astroschema capensis Mortensen, 1925: 152-155, pl. 8, figs 4-5, text-fig. 5; Mortensen, 1933c: 221, 227.
Asteroschema capensis: Clark and Courtman-Stock, 1976: 100, 108, 130; Sink *et al.*, 2006: 469-470.
Asteroschema capense: Okanishi and Fujita, 2009: 116, 119, 123, 125; Okanishi and Fujita, 2011: 149 (*lapsus calami*).
Asteromorpha capensis Okanishi *et al.*, 2013: 462-467, figs 2-5; Olbers *et al.*, 2014: 14, pl. 1F.

Diagnosis *- adapted from Okanishi et al. (2013).*

D.D. = 8mm; dorsal disc with skin covered ossicles, plate-shaped, polygonal, tessellated. Lateral interradial surface almost vertical. Radial shields tumid, with skin covered ossicles, almost meeting at centre of disc. Arms five, simple, flexible dorso-ventrally, no regular transverse rows of skin covered ossicles on dorsal and lateral surface, furrow to at least mid-arm. First to third tentacle pores lack arm spines, fourth pair with one spine, from fifth pair, two spines. Oral papillae 6-7, domed. Teeth 4-6, broad, triangular. Oral shields and adoral shields indistinct. Genital slits broad. Non-fissiparous. Colour in life reddish purple with creamy white spots on dorsal disc, white bands on dorsal and lateral surface of the arms, or body light brown dorsally and white ventrally.

Distribution and habitat

Mozambique, Madagascar, Somalia (Okanishi *et al.*, 2013), South Africa: Umvoti River (KZN) to Sodwana Bay (KZN); depth range: 64-500m.
Habitat: Rock, epizoic on gorgonians and other anthozoans. Sodwana Bay specimens associated with the gorgonian *Nicella dichotoma* (Sink *et al.*, 2006).

Remarks

The holotype of *Astroschema capensis* has an oral bridge on the ventral side of the vertebrae on the distal portion of the arms, as well as two arm spines from the fifth arm segment. These morphological features confirm an affiliation with the Euryalinae (Mortensen, 1933e; Okanishi and Fujita, 2011; Okanishi *et al.*, 2013). In addition, the disc and arms are covered mostly by skin covered ossicles, with the distal arm spines having a smooth basal lamina. These features required this species to be transferred to the genus *Asteromorpha* of the family Euryalidae. The holotype (examined), is in the Durban Natural Science Museum, as *Astroschema capensis,* (DNSM ECH1), is from 18-20 miles off Umvoti River Mouth, South Africa, depth 64-73m.

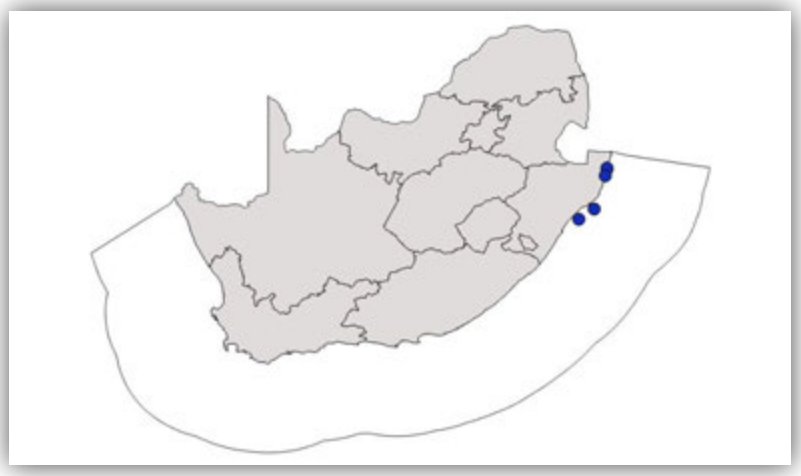

Figure 6.4. Distribution of *Asteromorpha capensis* in South Africa.

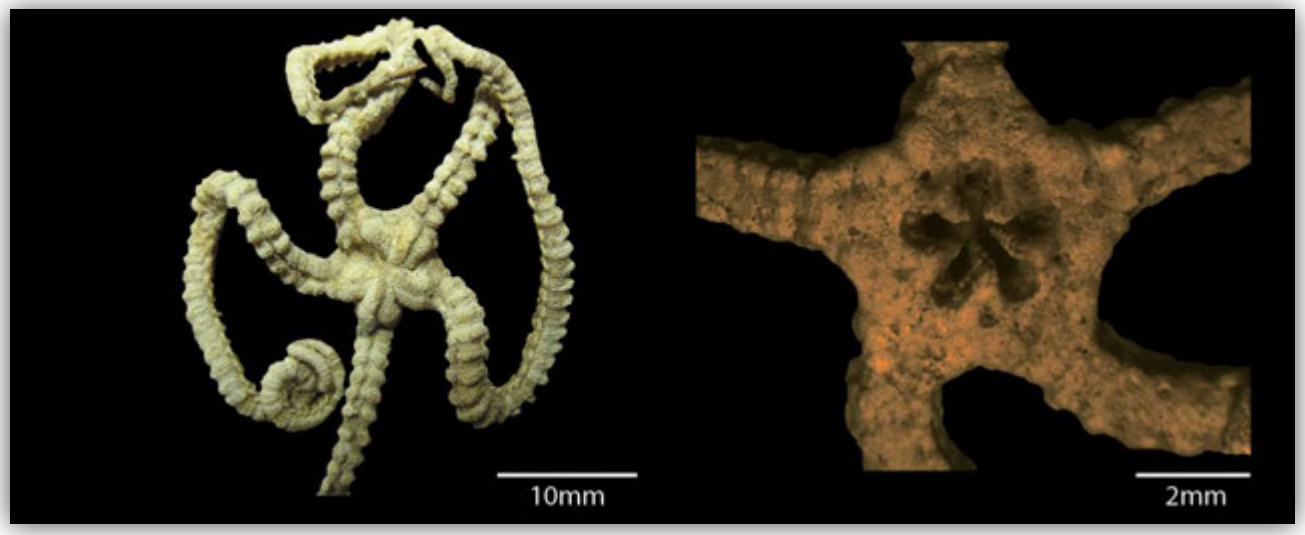

Figure 6.5. Dorsal (left) and ventral (right) views of *Asteromorpha capensis* (DNSM ECH1).

Genus Asterostegus Mortensen, 1933

Diagnosis *- adapted from Mortensen (1933c) and Okanishi and Fujita (2014).*
Arms simple, flexible dorso-ventrally, covered in tubercles dorsally. Radial shields covered in tubercles. Teeth present, triangular. Oral papillae domed, minute. Ventral interradial area with plates on distal side of adoral shields. Arm spines present from fourth arm segment. Ventral arms with oral bridge. Lamina of distal arm spines smooth.

Asterostegus tuberculatus Mortensen, 1933

Figs 6.6 and 6.7.

Asterostegus tuberculatus Mortensen, 1933c: 298-300, figs 24-26; Clark and Courtman-Stock, 1976: 100, 108, 128, figs 87, 96; Okanishi and Fujita, 2013: 568, 572, 575, fig. 1; Okanishi and Fujita, 2014: 1, 3-4, 12-17, figs 7-10.

Diagnosis *- adapted from Mortensen (1933c) and Okanishi and Fujita (2014).*
D.D. up to 23mm. Disc round, slightly notched interradially, covered in skin with stumps that are granule-shaped in centre and club-shaped on disc margin. Radial shields narrow, covered in skin and stumps. Arms five, simple, flexible dorso-ventrally. Dorsal arm plates indistinct, proximal lateral arm plates narrow with 2-3 club-shaped stumps. Ventral arm plates more distinct, 4-5 ossicles on each segment, decreasing in size distally, absent at arm tips. Proximal lateral arm plates with 2-3 stumps. Arm spines two from fourth pore, ovoid and small proximally, club-shaped at mid-arm and hook-shaped with smooth lamina on distal side. Oral shields small, not distinct, adoral shields large, hexagonal. 5-8 interradial plates forming two rows between disc margin and adoral shields. Jaws short, single vertical series of well-spaced spearhead-shaped teeth. Oral papillae 6-7, dome-shaped. Lateral interradial surface almost vertical. Genital slits two in each interradius. Madreporite, one. Colour in life unknown.

Distribution and habitat
Reunion (Okanishi and Fujita, 2014), South Africa: Durban (KZN); depth range: 382-500m.
Habitat: No notes recorded.

Remarks

No specimen was found or examined in the South African collections. According to Mortensen (1933c) and Clark and Courtman-Stock (1976) only a single specimen is known from the region (Natural History Museum of Denmark, holotype ZMUC OPH-307); off Durban, 382m. Okanishi and Fujita (2014) later redescribed *A. tuberculatus* based on a specimen found off the west coast of Reunion at 500m, in the Swedish Museum of Natural History (SMNH-123461).

Figure 6.6. Distribution of *Asterostegus tuberculatus* in South Africa.

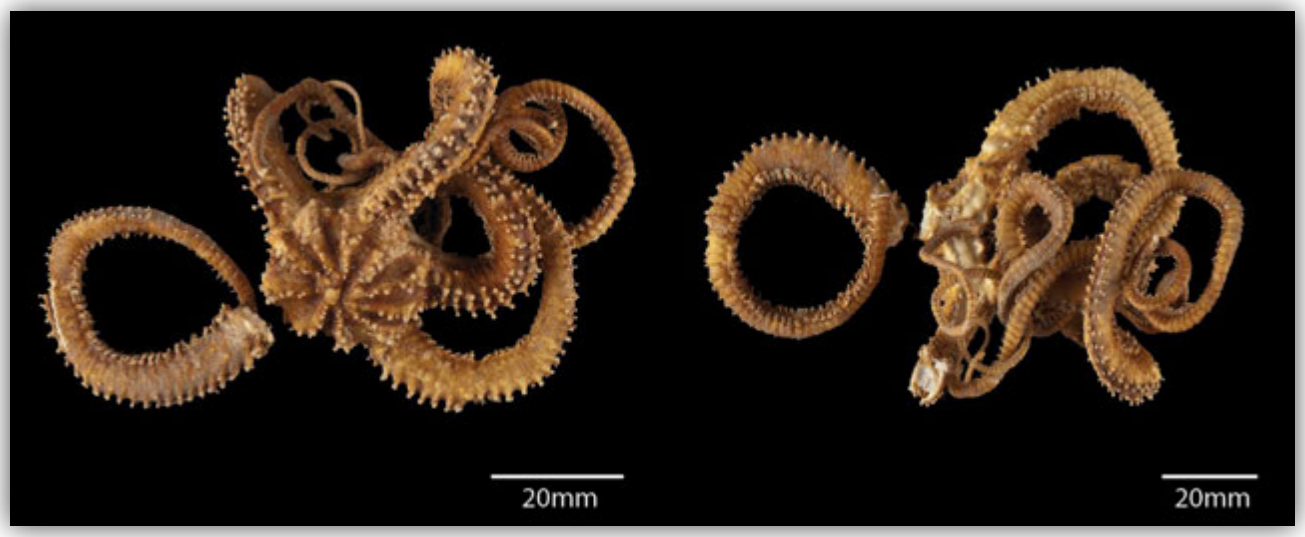

Figure 6.7. Dorsal (left) and ventral (right) views of *Asterostegus tuberculatus* (ZMUC OPH-307).

Genus Astroceras Lyman, 1879

Diagnosis *- adapted from Lyman (1879), Clark and Courtman-Stock (1976) and McKnight (2000).* Body covered in smooth skin. Disc naked or with spines or tubercles. Arms simple, flexible dorso-ventrally, scattered tubercles or spines on dorsal lateral ridge of arms. Radial shields narrow, tall, almost meeting in centre of disc, containing spines, tubercles or naked. Genital slits two, gonads ribbon-like extend into base of each arm. No true oral papillae but a clump of tubercles on lateral sides of jaws giving appearance of oral papillae. Teeth broad, triangular.

Astroceras spinigerum Mortensen, 1933

Figs 6.8 and 6.9.

Astroceras spinigerum Mortensen, 1933c: 296-297, fig. 23, pl. 28 figs 8, 9; Clark and Courtman-Stock, 1976: 100, 111, 128-129, fig. 94.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. = 8-13mm. Radial shields narrow, rib-like with 3-5 thick, cylindrical, smooth spines, outermost largest, tips rugose. Disc margin with scattered stumps, remainder of disc naked. Oral papillae small, warty. Infradental oral papillae slightly larger and elongated than oral papillae. Teeth five, conical, elliptical leaf-shaped. Adoral shields short, square. Oral shields rudimentary or absent. Arms simple, moderate in length, flexible dorso-ventrally, spines from radial shields continue down arms becoming smaller distally, one pair per segment. Dorsal arm plates indistinct. Ventral arm plates small, not contiguous. Lateral arm plates meeting on ventral side between ventral arm plates. Arm spines two from second pair of pores, short, cylindrical with thorny tip, hooked distally. Colour in life uniform greyish-brown.

Distribution and habitat
Mozambique (Clark and Courtman-Stock, 1976), South Africa: Durban (KZN) to Leven Point (KZN); depth range: 112-411m.
Habitat: Associated with sand, mud and sponges.

Remarks
No South African specimens were available for examination but Mozambican specimens were examined. Holotype is in the Natural History Museum of Denmark (ZMUC OPH-281), type locality off Durban, depth 411m.

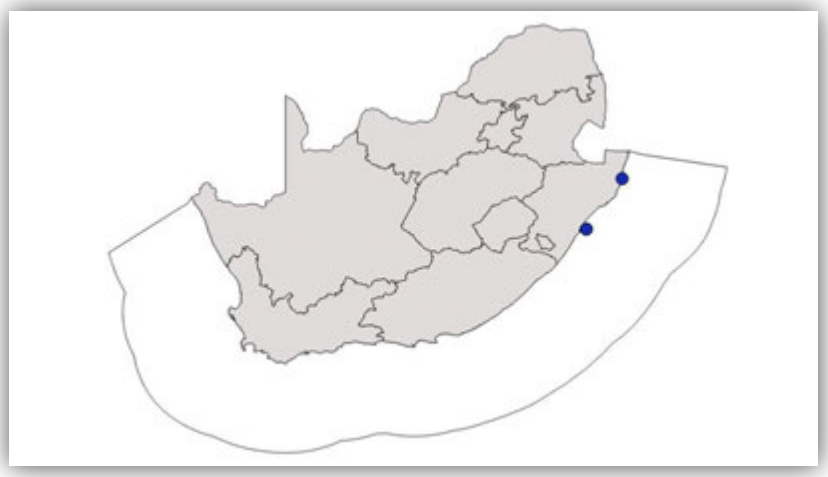

Figure 6.8. Distribution of *Astroceras spinigerum* in South Africa.

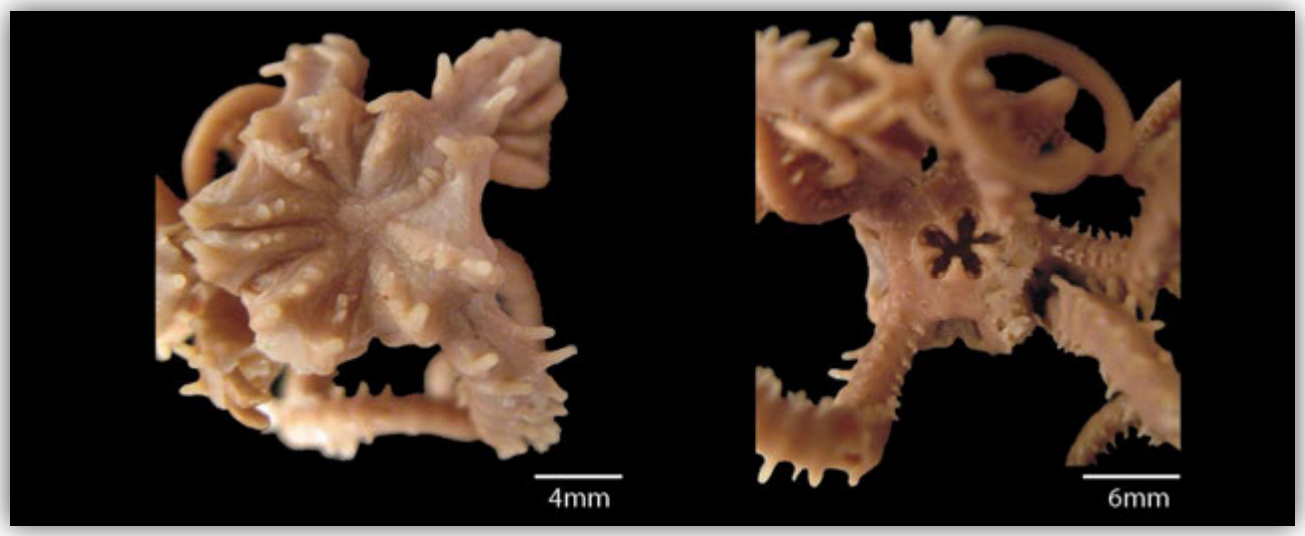

Figure 6.9. Dorsal (left) and ventral (right) views of *Astroceras spinigerum* (SAMC A23233).

Superfamily Gorgonocephalidea Okanishi and Fujita, 2013

Family ASTERONYCHIDAE Verrill, 1899

Diagnosis - *adapted from Verrill (1899b) and McKnight (2000).*
Radial shields, disc and arms covered with naked skin. Jaws with apical armament of oral papillae and teeth, not well-developed. Arms long, slender, simple, flexible dorso-ventrally. Vertebrae short, conspicuous continuous ventral groove, no belts of hooks on arms. Arm spines three or more, restricted to lateral arm plate, distal spines hook-like. Genital slits small, close to mouth. Gonads restricted to disc.

Genus *Asteronyx* Müller and Troschel, 1842

Diagnosis - *adapted from Müller and Troschel (1842) and McKnight (2000).*
Arms simple, covered in naked skin. Dorsal disc covered with naked skin, arm spines more than three, usually modified as simple hooklets. Oral papillae spiniform.

Asteronyx loveni Müller and Troschel, 1842

Figs 6.10 and 6.11.

Asteronyx loveni Müller and Troschel, 1842: 119-120, pl. 10, figs 3-5; Bell, 1892: 136-137; Koehler, 1907: 348; Clark, 1913: 219; Clark, 1915a: 180; Clark, 1923: 314-315; Döderlein, 1927: 59, 97, pl. 7, figs 7, 8; Mortensen, 1927: 158-160; Mortensen, 1933c: 300-301; Clark, A.M., 1952: 199, 212; Clark and Courtman-Stock, 1976: 100, 108, 129; Baker, 1980: 12, 16-18, figs 2, 3 (upper); Paterson, 1985: 13-15, fig. 9a-d; Alva and Vadon, 1989: 828-831, fig. 1a, b; Liao and Clark, 1995: 165-166, fig. 71; McKnight, 2000: 8, 13-15, pl. 1; Laguarda-Figueras *et al.*, 2009: 46, fig. 5.
Ophiuropsis lymani Studer, 1885: 55-46, pl. 5, fig. 12a-d; Clark, 1913: 213; Clark, 1915a: 180; Clark, 1923: 315, pl. 5, fig. 12a-d; Döderlein, 1930: 389, pl. 2, figs 11, 11a.
Asteronyx locardi Koehler, 1895: 470-471, fig. 10; Koehler, 1907: 348.
Asteronyx Cooperi Bell, 1909: 22.
Asteronyx dispar Lütken and Mortensen, 1899: 185, pl. 21, figs 1, 2, pl. 22, figs 10-12; Koehler, 1907:348; Clark, 1913: 218-219; Clark, 1915a: 180.
Ophiuraster patersoni Litvinova, 1998: 441-444, fig. 3.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 20mm. Disc inflated, pentagonal in shape, rounded margin. Disc and arms covered with naked skin. Radial shields narrow, smooth, almost meeting at centre of disc. Ventral disc sometimes with irregular plates. Oral shields seldom distinct, small or lacking in larger specimens, proximal margin bluntly pointed while distal margin rounded. Oral papillae on lateral side and apex of jaw, irregular, numerous, blunt. Teeth pointed, sometimes in single or multiple vertical series. Arms flexible dorso-ventrally, unequal in length, *c.*10 times D.D. No dorsal arm plates, vertebrae distinct. Ventral arm plates small, square to rectangular with rounded corners, but obscured by skin. Lateral arm plates large. Arm spines 3-9, hook-shaped, lowest arm spine largest, long, club-shaped, thorny. Genital slits short, *c.* single segment length, lying well within ventral interradial area. No tentacle scales on first pair of pores. Madreporite distinct. Colour in life red.

Distribution and habitat
Almost cosmopolitan, Indian Ocean, discontinuous in Pacific and Atlantic Oceans (Rowe and Gates, 1995; McKnight, 2000), South Africa: Orange River (NC) to Cape Town (WC); depth range: 62-4 721m.
Habitat: Mud and sand, associated with gorgonians and pennatulids.

Remarks
Known to cling to pennatulids and gorgonians (Mortensen, 1927; Hyman, 1955). Clark (1923) reported that the only difference between the southern African form and the northern form are that the oral papillae are shorter, flatter and more regularly arranged in the southern African form.

Syntypes are in the Swedish Museum of Natural History, SMNH Type-3288 (Finnmark); SMNH Type-3732 (Kattegat); SMNH Type-3287 (Kattegat; south west Sweden as 'Bohuslän, Norway as far as Hammerfäst') (Stöhr, 2007c), Bay of Biscay (Clark and Courtman-Stock, 1976).

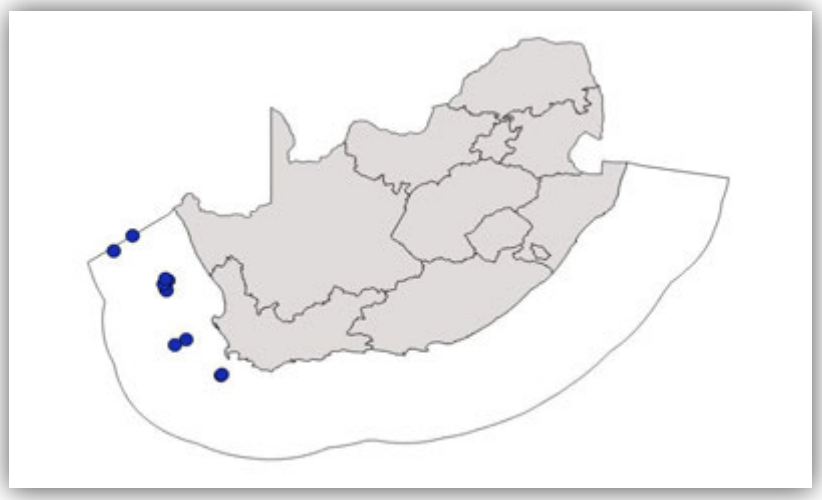

Figure 6.10. Distribution of *Asteronyx loveni* in South Africa.

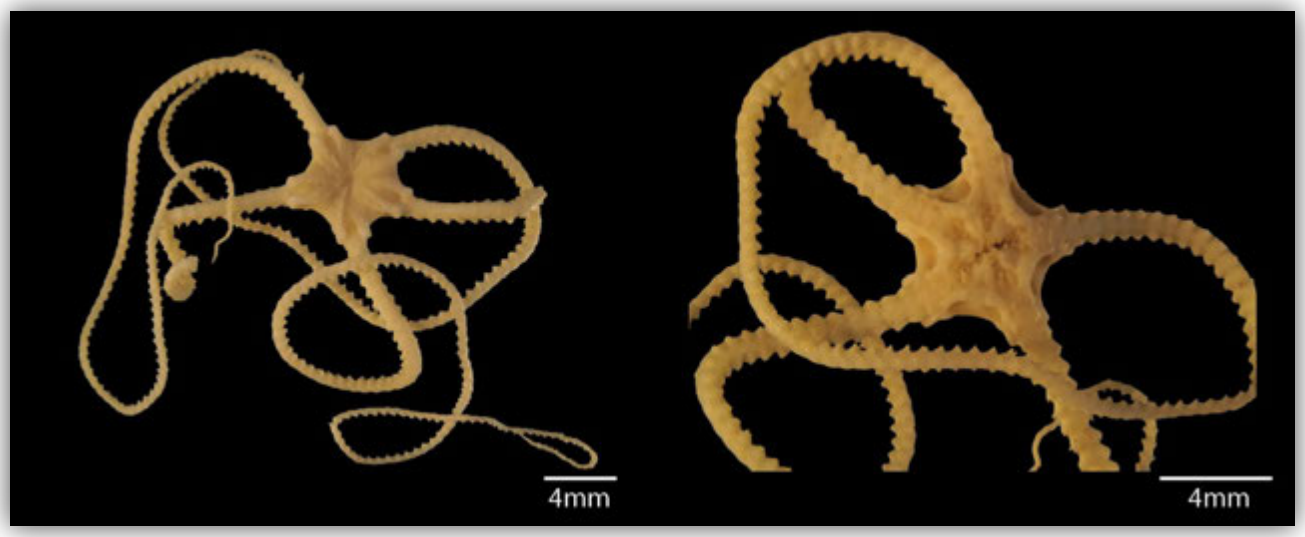

Figure 6.11. Dorsal (left) and ventral (right) views of *Asteronyx loveni* (SAMC A22013).

Family GORGONOCEPHALIDAE Ljungman, 1867

Diagnosis *- adapted from Ljungman (1867b) and McKnight (2000).*
Large disc, arms simple or branched, skin naked, tuberculated. Radial shields narrow, elongated, either naked or armed with spines and / or tubercles. Jaws armed with mostly spiniform papillae, may be clustered at apex of jaw, no clear distinction between teeth and oral papillae. Arms long, simple or branched, flexible dorso-ventrally, with longitudinal ventral groove, belts of hooks (girdle belts) on dorsal segments for most of arms, giving arms annulated appearance, no true dorsal arm plates, lateral and ventral arm plates present, distal arm segments / vertebrae short. Arm spines up to six proximally, but generally 2-3. Gonads restricted to disc. Madreporite either single or one in each interradius.

Genus Astroboa **Döderlein, 1911**

Diagnosis *- adapted from Döderlein (1911) and McKnight (2000).*
Radial shields elongated, converging towards centre, may be covered with small tubercles. Interradial areas usually have small tubercles, not uniformly placed. Arms branched, flexible dorso-ventrally. Belts of hooks (girdle belts) present as patches on lateral sides of arm then becoming continuous after fifth fork, girdle hooklets with curved terminal tooth and secondary tooth. No arm spines before the fourth fork, initially two then increasing up to five, with glassy tips, distally becoming flattened multi-tooth hooklets. Madreporite one.

Astroboa nuda **(Lyman, 1874)**
Figs 6.12 and 6.13.

Astrophyton nudum Lyman, 1874: 251-252, pl. 6, figs 4-5.
Astrophyton elegans Koehler, 1905b: 123-125, pl. 13, fig. 2, pl. 18, fig. 1.
Astroboa nuda: Döderlein, 1911: 86-88; Mortensen, 1940: 67; Tsurnamal and Marder, 1966: 9-17, figs 1-4; Clark and Courtman-Stock, 1976: 100, 108, 130-131; Cherbonnier and Guille, 1978: 17-18, pl. 1, figs 3-4; Baker, 1980: 60, fig. 22; Guille and Vadon, 1985: 62; Marsh, 1986: 70; Olbers *et al.*, 2015: 85, 88.
Astroboa nigra Döderlein, 1911: 83-86, pl. 9. Figs 9, 9a.
Astroboa nuda var. *elegans*: Döderlein, 1927: 45.

Astroboa nuda var*. nigra*: Döderlein, 1927: 44; Balinsky, 1957: 2-3.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Baker (1980).*
D.D. up to 92mm. Disc depressed interradially and centrally, interradial and radial areas naked towards centre of disc, but with increasing presence of tiny tubercles towards disc margin. Radial shields narrow, paved densely with low granules giving smooth appearance, raised at disc margin, slightly broader on distal side, terminating in oval slightly concave plate, converging to centre of disc. Ventral interradial areas densely covered with tiny tubercles. Oral papillae short, narrow, no continuous fringe in distal notches. Teeth 3-5, thicker than oral papillae but elongated. Arms higher than wide basally, branched, first fork close to disc base, 4-8 segments between forks with up to 28 forks along arm, flexible dorso-ventrally. Arms covered in small, smooth, polygonal plates. Bands of hooks (girdle belts) present on arms from after second fork, but continuous before third branch, girdle hooklets with secondary tooth. Arm spines absent before fifteenth fork on main arm stem, but may occur from fourth fork on secondary stems, spines 3-4 with distal spines becoming hooklets with two hooks. Genital slits small, wide. Genital papillae present on inner edge. Madreporite one. Colour in life black, white or yellow.

Distribution and habitat
Western Indian Ocean, Red Sea, East Indies, Persian Gulf, China and south Japan, Philippines, Australia (Balinsky, 1957; Kalk, 1958; Macnae and Kalk, 1958; Tsurnamal and Marder, 1966; Clark and Rowe, 1971; Clark and Courtman-Stock, 1976; Cherbonnier and Guille, 1978; Rowe and Gates, 1995; Richmond, 2002), South Africa: Sodwana Bay (KZN) (Sink *et al.*, 2006); depth range: intertidal-120m.
Habitat: Found on coral reefs, both within deep crevices and on open reef.

Remarks
Reported as new record for South Africa by Olbers *et al.* (2015). Previously known from Mozambique and hence not surprisingly recorded in South Africa. According to Rowe and Gates (1995), type locality is Philippines, with the holotype being in the Museum of Comparative Zoology (MCZ OPH-2911).

Two specimens were found at Sodwana Bay since the Olbers *et al.* (2015) paper which only reported up to 20 forks, as opposed to 28 as reported by Baker (1980).

A notable difference between *Astroboa* and *Astrocladus* is that the arm spines in *Astroboa* are found after the fourth fork, while in *Astrocladus* they occur from either first or second forks, however, this difference is not obvious in young specimens (Baker, 1980).

Figure 6.12. Distribution of *Astroboa nuda* in South Africa.

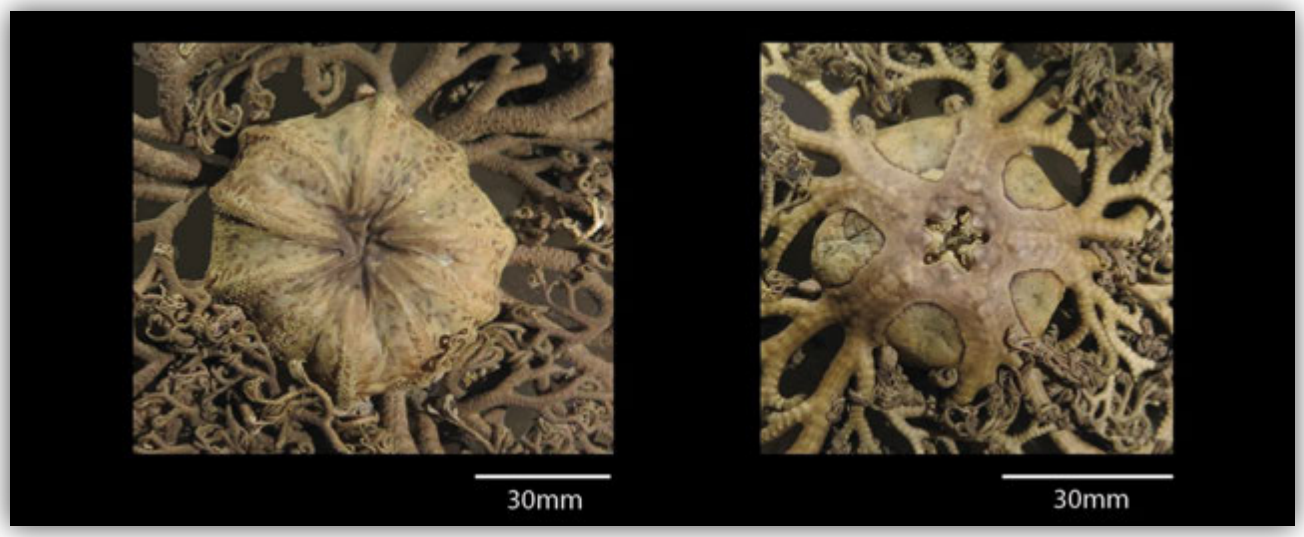

Figure 6.13. Dorsal (left) and ventral (right) views of *Astroboa nuda* (SAMC A081578).

Genus Astrocladus Verrill, 1899a

Diagnosis - *adapted from Verrill (1899a) and McKnight (2000).*
Disc armed with flat or conical tubercles, no belts of marginal platelets. Oral papillae present in distal notches (except in *A. hirtus*). Arms branched, belts of hooks (girdle belts) present, flexible dorso-ventrally. Often more arm segments before the first fork than between first and second forks, no more than 11 segments between successive forks distally. Arm spines small, begin after segments bearing second or third pores.

Astrocladus africanus Mortensen, 1933

Figs 6.14 and 6.15.

Astrocladus africanus Mortensen, 1933c: 291-293, fig. 20, pl. 17, figs 1, 2; Clark and Courtman-Stock, 1976: 108, 131, fig. 92.

Diagnosis - *adapted from Mortensen (1933c).*
D.D. = 58mm, dorsal disc with moderately sized conical tubercles, denser on radial shields and centre of disc, interradial areas with fewer tubercles. Radial shields converge towards centre of disc. Ventral interradial areas with few scattered tubercles, mouth frame and ventral arms covered with small irregular plates. Jaws thick, elevated. Oral papillae clustered on apex of jaw and fringe mouth slits including in distal notches. Arms flexible dorso-ventrally, first arm forks lie on disc, distance between successive forks short, 7-8 segments between forks, arms with more than eight forks. Dorsal arms with dense, uniform mosaic of small, smooth, almost flat plates, no larger tubercles, distinct sunken dorsal midline, spaces between segments somewhat sunken, with irregular larger oval plates found in sunken rings. Belts of hooks (girdle belts) present. Arm spines at first branch, sometimes at second and third pores, two, short, slightly curved and ending in a single thorn. Spines become hook-shaped distally, with 2-4 hooklets, serrated on convex edge. Genital slits short. Genital papillae absent. Madreporite close to edge of mouth frame, scarcely protruding into interradius. Colour in life unknown.

Distribution and habitat
South Africa; depth range: unknown
Habitat: Unknown.

Remarks

Considered endemic, only a single specimen is known, which was found during a South African Fisheries Survey (Mortensen, 1933a) but for which more detailed locality data are not available. Holotype in the Natural History Museum of Denmark (ZMUC OPH-74), type locality 'South Africa'.

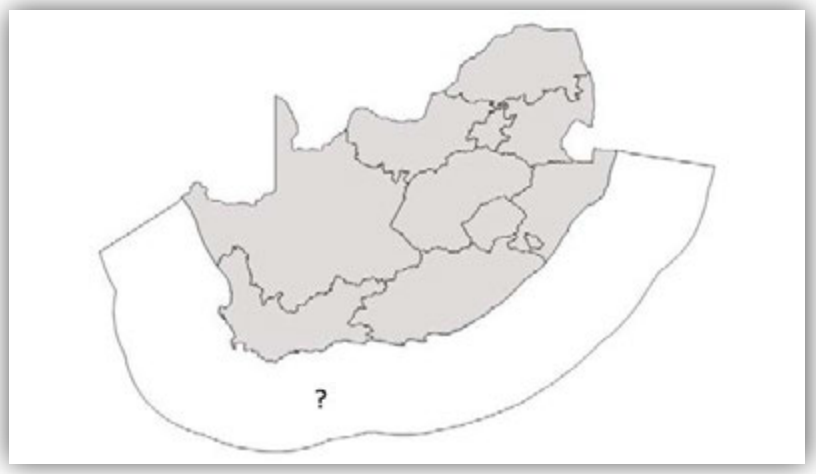

Figure 6.14. Distribution of *Astrocladus africanus* in South Africa.

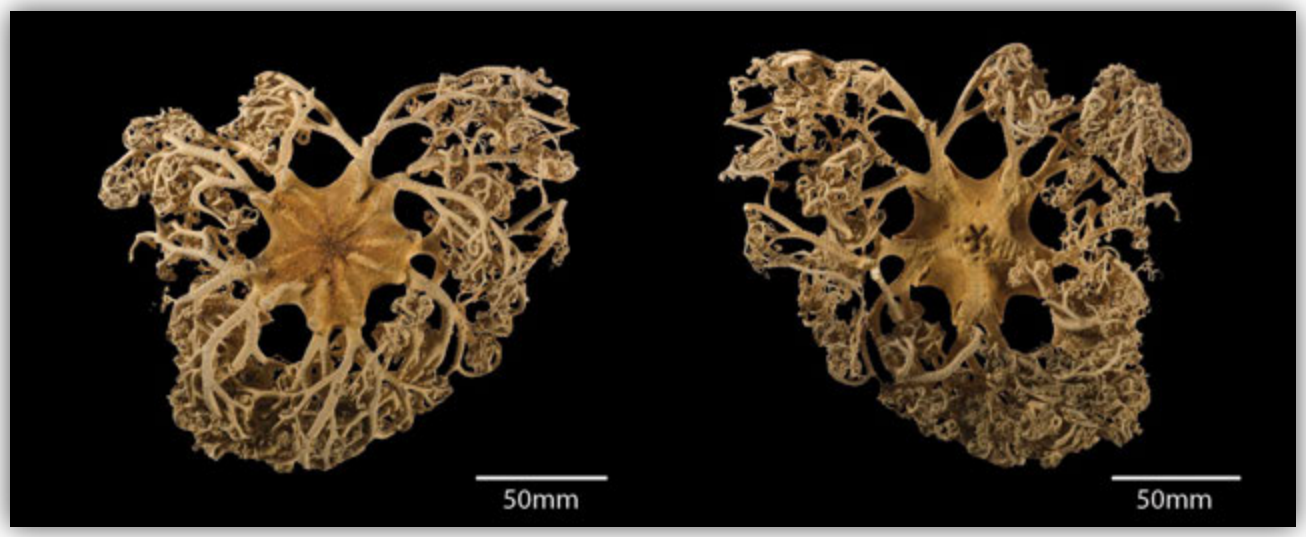

Figure 6.15. Dorsal (left) and ventral (right) views of *Astrocladus africanus* (ZMUC OPH-74).

***Astrocladus euryale* (Retzius, 1783)**

Figs 6.16 and 6.17.

Asterias euryale Retzius, 1783: 243-244.
Astrocladus euryale: Döderlein, 1911: 6, 75; Clark, 1923: 319; Mortensen, 1933c: 293-296, figs 21, 22, pl. 18, fig. 7; Clark, A.M., 1952: 199; Day *et al.*, 1952: 412; Day *et al.*, 1970: 80; Clark, 1974: 440-441, pl. 3, figs 1, 2; Clark and Courtman-Stock, 1976: 100, 108, 131, figs 89, 90, 91; Branch *et al.*, 2010: 230, fig. 103.1.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*

D.D up to 75mm, disc smooth. Radial shields armed with moderate to large round tubercles, converging towards centre of disc. Dorsal arms coated with similar tubercles, continued down arm, tubercles absent distally, belts of hooks (girdle belts) present proximally. Arms branched, flexible dorso-ventrally, first fork beyond base, 6-9 segments between forks. Lateral arm plates short, barely reaching edge of the arm, ventral arm plates not well-developed. Ventral disc smooth, naked skin

including jaws, oral and adoral shields indistinct. Oral papillae spiniform, fringe oral area including distal notches. Arm spines at first fork, sometimes before. Arm spines conical, becoming hook-shaped distally. Genital slits small, no genital papillae. Colour in life white and / or grey with black surrounding tubercles on disc and arms, arms and radial shields dark brown to black with white tubercles, interradial areas white.

Distribution and habitat
South Africa: Cape Town (WC) to Amatikulu (KZN); depth range: 11-555m.
Habitat: Rock, sand, shell, mud and sponge.

Remarks
The most common basket star in South Africa and frequently seen and photographed by divers. When live, the arms and radial shields are dark brown to black with white tubercles and white interradial areas. The colouration is distinctive and easily identified positively by divers. When preserved, colouration often duller, but the darker areas are accentuated in comparison to the white / lighter areas.

Astrocladus euryale is endemic to South Africa (see Table 7.4). There have been three reports of distribution outside SA, namely Providence Island, Northern Madagascar (Bell, 1905), Jobi, New Guinea and the Moluccas (Stiasny and Groenewegen, 1929), but Mortensen (1933c) dispelled these records based on corrected identification of Bell's specimens and this was confirmed by Dr Stiasny saying that the specimen labels were unreliable (Mortensen, 1933c).

Location of the type specimen is unknown, type locality, 'Cape of Good Hope', depth unknown.

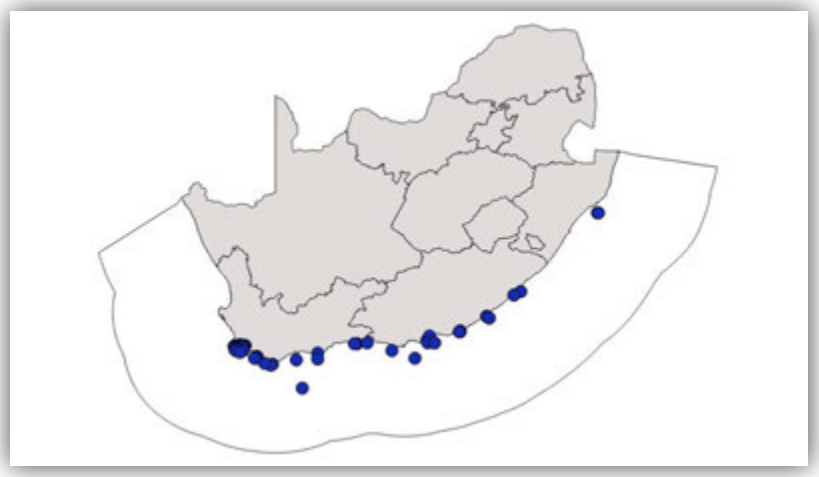

Figure 6.16. Distribution of *Astrocladus euryale* in South Africa.

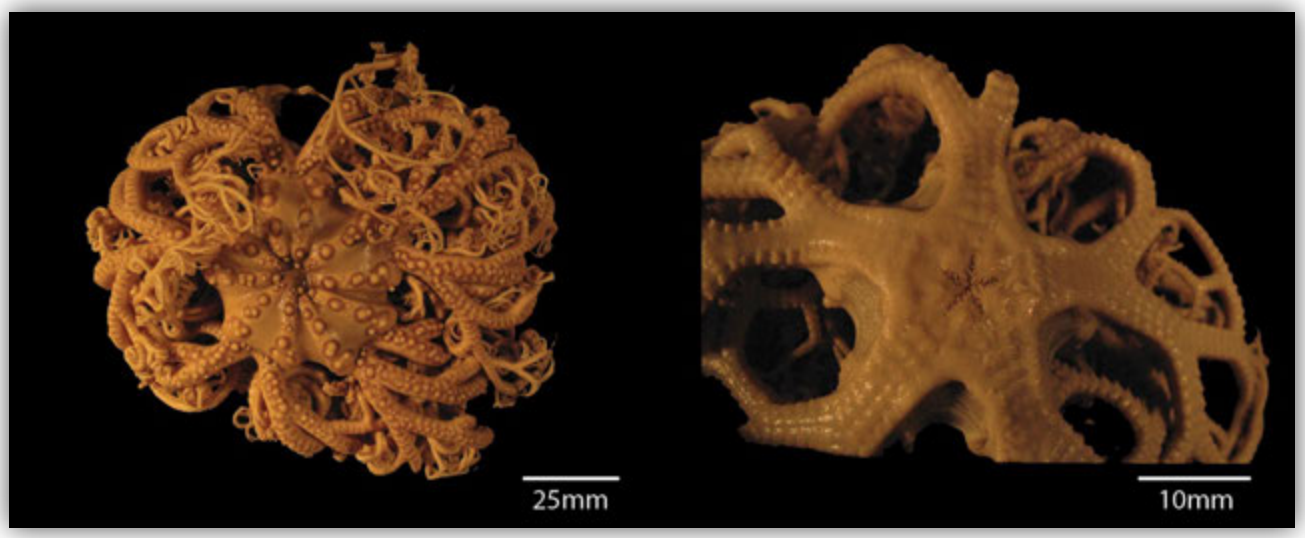

Figure 6.17. Dorsal (left) and ventral (right) views of *Astrocladus euryale* (SAMC A084243).

***Astrocladus hirtus* Mortensen, 1933**

Figs 6.18 and 6.19.

Astrocladus hirtus Mortensen, 1933c: 288-290, fig. 17, pl. 19, figs 1-3; Clark and Courtman-Stock, 1976: 101, 132.
Astrocladus hirtus var. *reticulatus* Mortensen, 1933c: 290-291, pl. 18, figs 5, 6.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 25mm, disc pentagonal. Radial shields elevated, narrow, almost reaching centre of disc, not parallel, covered by small conical tubercles terminating in one or two very small thorns. Dorsal interradial areas and between radial shields coated in granules with some conical tubercles, tubercles becoming slightly larger on distal ends of radial shields. Ventral disc covered in small granules, few scattered conical granules in interradial areas. Oral papillae forming dense cluster at apex of jaws, no oral papillae in distal notches, lowermost papillae with sharp pointed tips, remaining papillae blunt or round. Arms five, branched, flexible dorso-ventrally, smooth, first fork within disc, 3-6 segments between forks, up to 12 forks. Arm spines 2-3 basally then 4-5 distally, short, with one or several hyaline thorns; arm spines begin at the second fork, but more developed from third fork. Ventral groove along most of the length of the arms. Dorsal sides of arms covered by granules, belts of hooks evident both dorsally and laterally, belts becoming complete after fifth fork, belts indistinct on most specimens. Genital slits small and restricted to edge of disc, adjacent to first fork, no genital papillae, but spines present on radial side of each genital slit. Single madreporite at edge of interradius close to jaws. Colour in life brown to yellow, lighter ventrally.

Distribution and habitat
South Africa: Aliwal Shoal (KZN) to Sodwana Bay (KZN); depth range: 12-111m.
Habitat: Seen at night, attached to firm substrates; often in crevices (Yves Samyn, pers. comm.) and / or under large coral boulders.

Remarks
Endemic to South Africa, in northern KZN waters (see Table 7.4). This study increased the known depth range from 24 to 111m. Syntype housed at the Natural History Museum of Denmark (ZMUC OPH-125), type locality uncertain, Natal coast or possibly Mozambique (Clark and Courtman-Stock, 1976). A paratype (examined), from the Tugela Banks (SAMC A22382) is in the Iziko South African Museum.

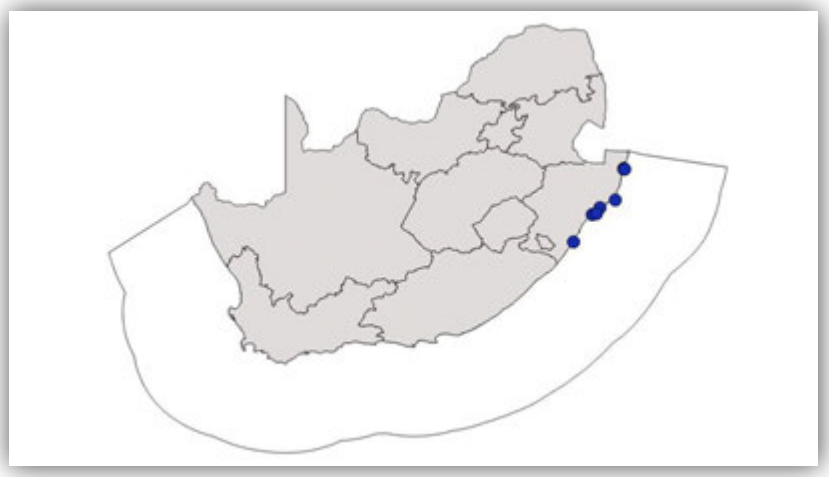

Figure 6.18. Distribution of *Astrocladus hirtus* in South Africa.

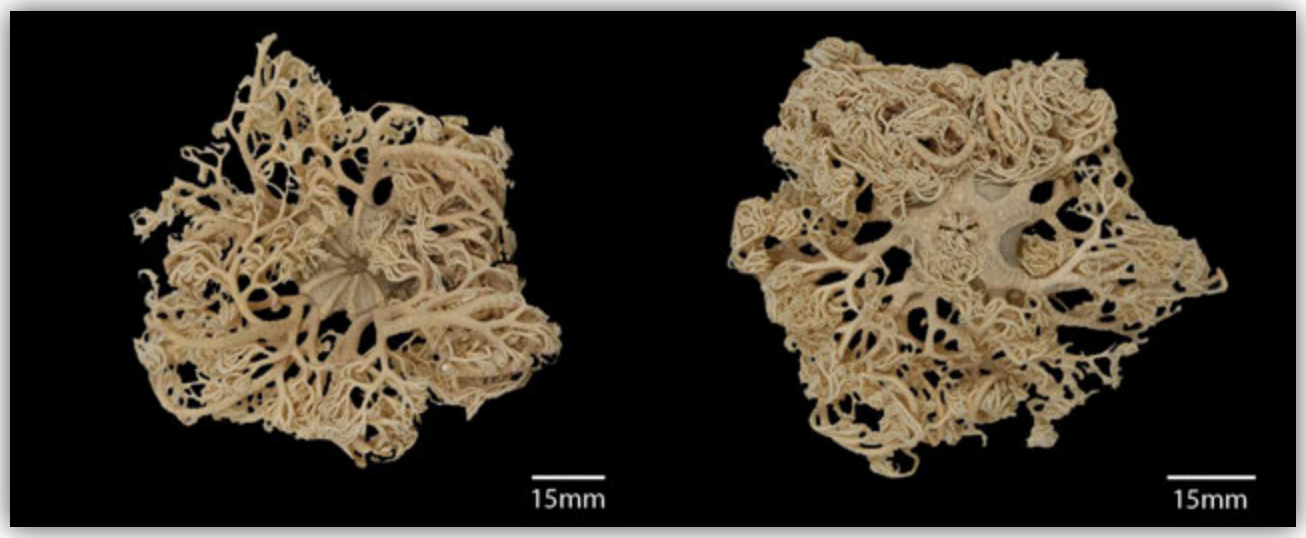

Figure 6.19. Dorsal (left) and ventral (right) views of *Astrocladus hirtus* (RMCA MT2186).

Genus Astrodendrum **Döderlein, 1911**

Diagnosis *- adapted from McKnight (2000) and Döderlein (1911).*
Teeth, oral papillae and dental papillae similar, spiniform. Genital slits small, often pore-like and close to disc margin. Arms flexible dorso-ventrally, basal vertebrae not very small, belts of hooks present, hooklets in patches on dorsal side at base of arms.

Astrodendrum capensis **(Mortensen, 1933)**

Figs 6.20 and 6.21

Astroconus capensis Mortensen, 1933c: 285-288, fig. 18a-d, pl. 18, figs 3, 4; Clark and Courtman-Stock, 1976: 100, 132; Alva and Vadon, 1989: 829-830, 831, fig. 1c, d.
Astrodendrum capensis: Baker, 1980: 58.

Diagnosis *- adapted from Mortensen (1933c) and Baker (1980).*
D.D. up to 90mm. Disc and arms covered in fine granules. Disc with few intermixed conical and warty tubercles towards disc margin and radial shields, denser in centre of disc. Radial shields narrow,

slightly broader on distal side, converging towards centre. Mouth frame covered in dense mosaic of small, flat, polygonal plates, arms similar. Oral papillae long, spiniform and stout on apex, forming continuous fringe including in distal notches. Arms branched, flexible dorso-ventrally. First fork beyond base, 8-9 segments between first and second forks, up to 20 segments distally. Belts of hooks begin on third to fourth fork. Arm spines short, begin on second pair of oral pores. Genital slits small, pore-like and close to disc margin. Genital papillae present.

Distribution and habitat

Namibia, South Africa: Orange River (NC) to Leven Point (KZN); depth range: 161-420m.
Habitat: Found in sandstone, rubble, broken shell, coarse sand and attached to gorgonians.

Remarks

Distribution range here extended north-east from Durban to Leven Point and west from Durban to the Orange River (see Table 7.3).

Baker (1980) placed *Astroconus capensis* Mortensen, 1933 in the genus *Astrodendrum* Döderlein, 1911 after re-examination of the holotype in the Natural History Museum of Denmark (ZMUC OPH-80), because of the presence of girdle hooklets in patches on the dorsal side at the base of the arms, which is a character unknown in *Astroconus,* but present in all *Astrodendrum* species. Type locality is off Durban, depth 420m.

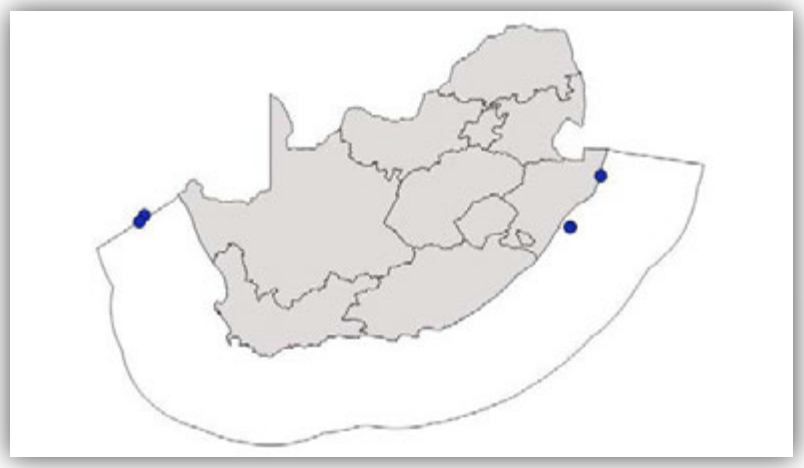

Figure 6.20. Distribution of *Astrodendrum capensis* in South Africa.

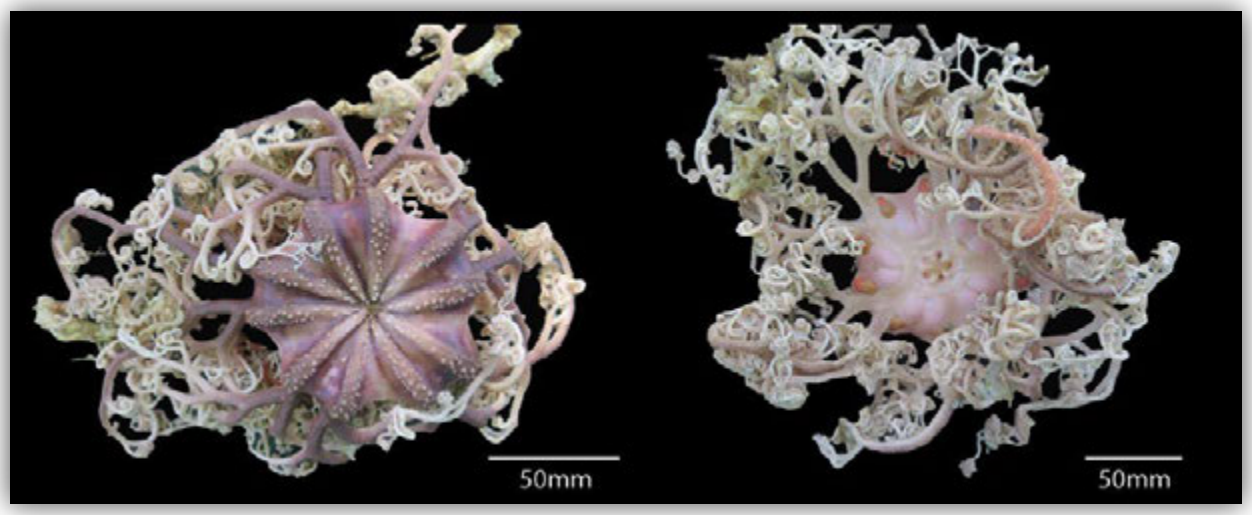

Figure 6.21. Dorsal (left) and ventral (right) views of *Astrodendrum capensis* (SAMC A088481).

Genus Astroglymma Döderlein, 1927

Diagnosis *- adapted from Döderlein (1896) and Döderlein (1927).*
Disc tubercles fine, all similar in size. Arms branched, flexible dorso-ventrally, *c.*16 forks. Arm spines 2-3, minute. Madreporites five, equal in size.

Astroglymma* cf. *sculptum (Döderlein, 1896)
Figs 6.22 and 6.23.

Astrophyton sculptum Döderlein, 1896: 299, pl. 18, fig. 29a, b; Baker, 1980: 66, 74, figs 19, 28, 31.
Gorgonocephalus robillardi De Loriol, 1899: 31-34, pl. 3, fig. 3.
Astrodactylus robillardi: Döderlein, 1911: 96-98.
Astroglymma sculptum Döderlein, 1927: 47-50, pl. 1, figs 3, 4; pl. 5, fig. 13; Koehler, 1930: 15, pl. 2, figs 10-12; Guille and Vadon, 1985: 62; Liao and Clark, 1995: 170, fig. 74; Okanishi *et al.*, 2011c: 380-381, fig. 7; Olbers *et al.*, 2015: 88-89, pl. 1C, D.
Astroglymma robillardi: Mortensen, 1933e: 34, pl. 3, figs 1, 2; pl. 4, fig. 1.
Astroglymna sculptum: Rowe and Gates, 1995: 365 (*lapsus calami*).

Diagnosis *- adapted from Baker (1980).*
D.D. up to 50mm. Disc deeply excavated interradially. Radial shields long, slender, widely separated distally, almost touching proximally, almost reaching centre of disc. Disc and radial shields covered in minute conical tubercles, ventral interradial area may bear long spinelets. Oral shields smooth, adoral shields not distinct, deep pits bordering jaws. Oral papillae unequal, small, mostly spiniform. Teeth small, spatulate. Arms branched, flexible dorso-ventrally, first fork just beyond disc, forking at least 20 times along arm. Dorsal arms covered in low polygonal plates. Belts of hooks (girdle belts) narrow, present from arm bases, girdle hooklets with secondary tooth. Arm spines present from sixth fork as two stumps, becoming three with one or two terminal points, distally becoming hooklets with terminal point and smaller secondary tooth. Ventral arms covered with smaller flat polygonal plates, ventral arms have ladder-like pits on first 2-3 forks. Genital slits short, D-shaped. Genital papillae blunt-tipped on outer edge. Five madreporites present in angle of ventral interradial area.

Distribution and habitat
Mauritius, India, China Sea, Malaysian Archipelago, Australia (Baker, 1980; Imaoka *et al.*, 1991; Rowe and Gates, 1995), South Africa: off Durban (KZN); depth range: 68-70m.
Habitat: No notes recorded.

Remarks
Reported as new to South Africa by Olbers *et al.* (2015), found off Durban in KZN.

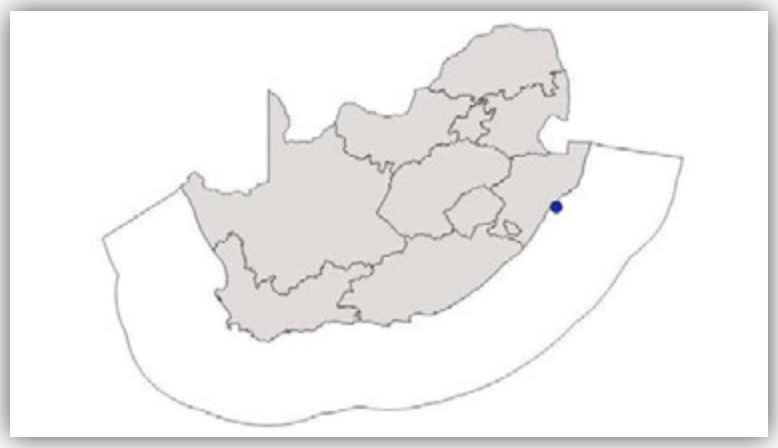

Figure 6.22. Distribution of *Astroglymma* cf. *sculptum* in South Africa.

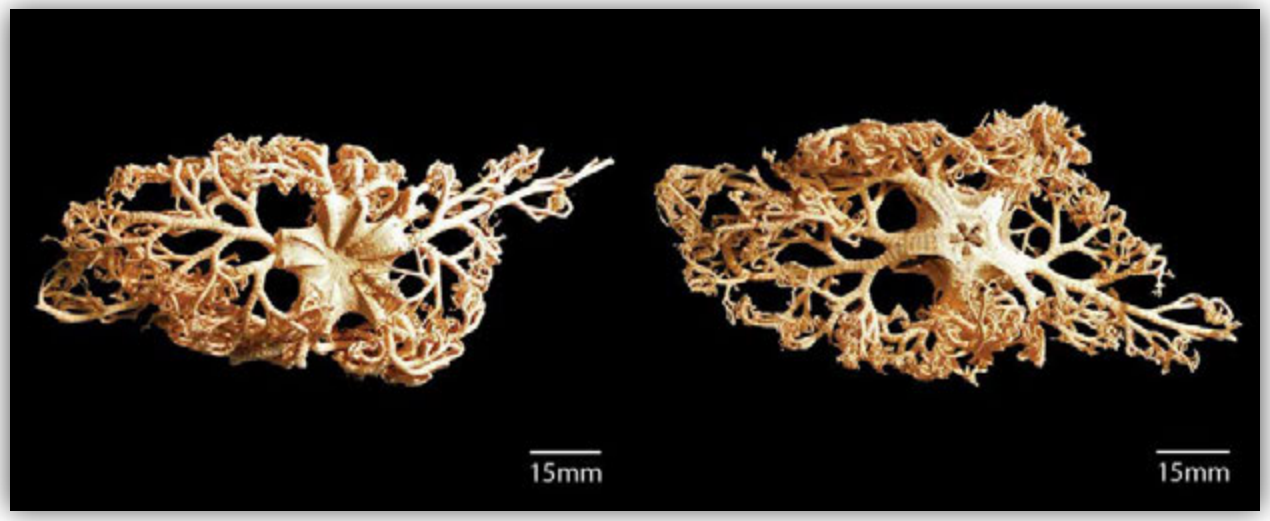

Figure 6.23. Dorsal (left) and ventral (right) views of *Astroglymma* cf. *sculptum* (USNM 1072476).

Genus Astrothorax Döderlein, 1911

Diagnosis - *adapted from Döderlein (1911) and McKnight (2000).*
Arms simple, flexible dorso-ventrally, disc covered in tubercles, arm spines 5-10, hooklets with single secondary tooth.

Astrothorax waitei (Benham, 1909)

Figs 6.24 and 6.25.

Astrotoma waitei Benham, 1909: 101-104, pl. 9, figs 1-6; Mortensen, 1924: 104, pl. 4, fig. 2; Fell, 1952: 13-14.
Astrothamnus rugosus Clark, 1916: 85-86, pl. 35, figs 1, 2; Clark, 1946: 177.
Astrothamnus papillatus Clark, 1923: 316-318, pl. 20, figs 5, 6.
Astrocrius waitei: Döderlein, 1927: 21.
Astrothorax waitei: Rowe and Gates, 1995: 366; McKnight, 2000: 61-62, 72-73, pl. 29; Mah *et al.*, 2009: 379, 396.
Astrothamnus furtivus Koehler, 1930: 6, pl. 1, figs 1, 2; Mortensen, 1933e: 22, pl. 5, fig. 33; Clark, 1946: 177.
Astrothorax furtivus: Mortensen, 1933e: 22, 23, fig. 13, pl. 5, fig. 33. McKnight, 1975: 61.
Astrothorax papillata: Mortensen, 1933c: 279-280, fig. 15; Clark, A.M., 1952: 199; Clark and Courtman-Stock, 1976: 100, 108, 132.

Diagnosis - *adapted from Benham (1909) and Clark and Courtman-Stock (1976).*
D.D. up to 20mm. Disc tumid dorsally, flat ventrally, with interradial areas slightly excavate. Radial shields form distinct ridges, upper surface with coarse and fine tubercles intermixed, tubercles wider than high, rounded or truncated, smooth or have fine glassy, prickly protrusions. Ventral disc tubercles abruptly finer, conceal oral shields. Disc margin paved with low smooth tubercles. Arms five, long, simple, flexible dorso-ventrally, dorsally rounded, alternating bands of fine and coarse tubercles, fine tubercles bear numerous hooks and hooklets, while coarser tubercles more or less smooth. Arm spines begin at second tentacle pore, two, short, thorny, increasing in number up to ten. Arm spine shape changes from thorny-tipped stumps proximally to F-shaped hooks distally. Distal arm spines have large terminal tooth with smaller secondary tooth. Jaws covered by uniform fine tubercles, coarsest interradially. Teeth, tooth-papillae and oral papillae similar, spiniform, teeth larger, oral papillae small. Genital slits small, no genital papillae.

Distribution and habitat
Temperate waters, southwest Pacific and Australia (Rowe and Gates, 1995), South Africa: Cape Point (WC) to Durban (KZN); depth range: 0-1 005m.
Habitat: Mud, sand and attached to coral or coralline algae.

Remarks
Identified specimens in the Iziko South African Museum labelled as *A. papillata*.

Holotype, as *Astrothorax papillatus,* (SAMC A6443; examined), type locality off Cape Hangklip, depth 110m. Syntype, as *Astrothorax waitei,* in Canterbury Museum, Christchurch (New Zealand) (Rowe and Gates, 1995) with type locality as east coast of Otago, New Zealand.

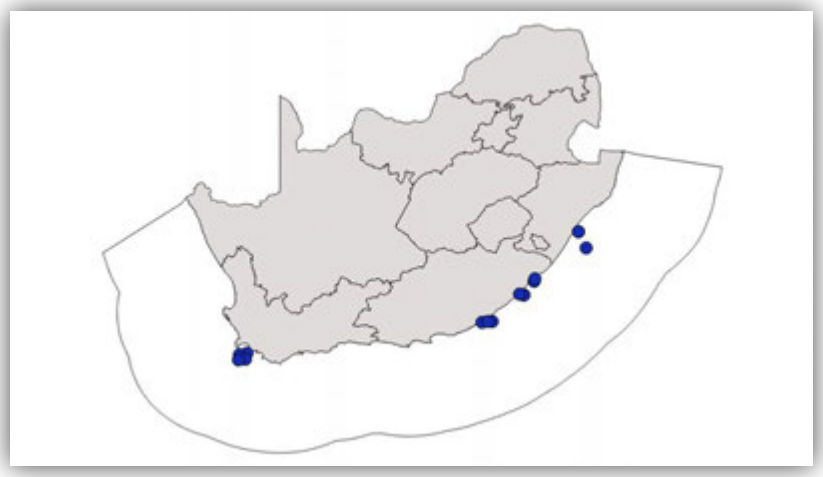

Figure 6.24. Distribution of *Astrothorax waitei* in South Africa.

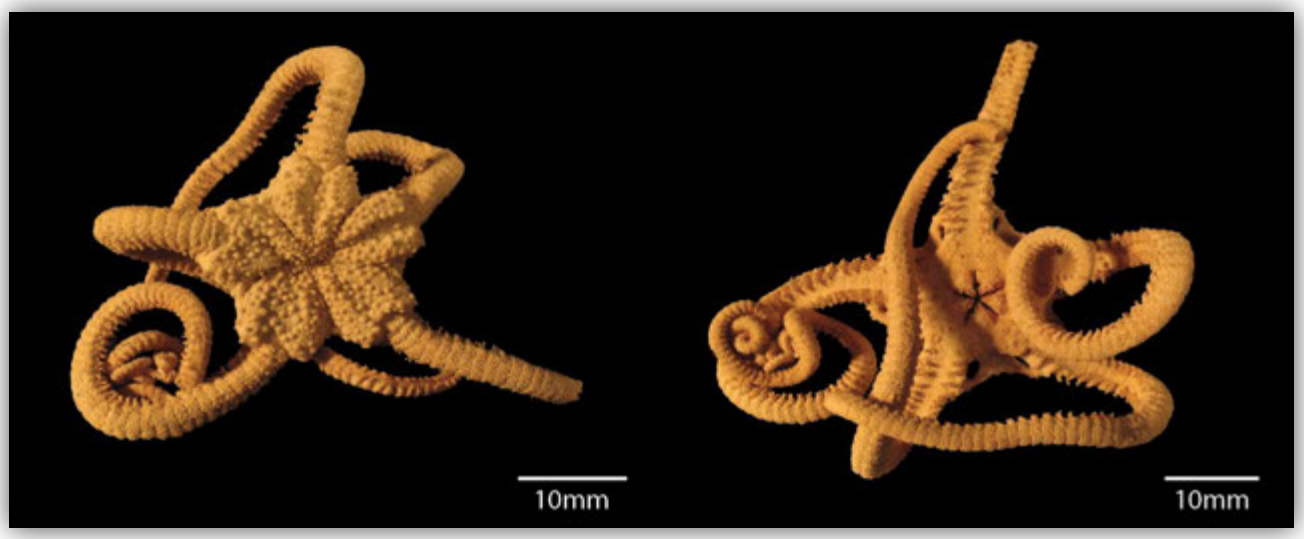

Figure 6.25. Dorsal (left) and ventral (right) views of *Astrothorax waitei* (SAMC A7519)

Genus Gorgonocephalus **Leach, 1815**

Diagnosis *- adapted from Leach (1815) and McKnight (2000).*
Disc and arms covered with small or spiny tubercles, disc margin contains plates. Radial shields narrow, elongated. Arms five, flexible dorso-ventrally, first fork near disc, dorsally with annulated bands of hooks (girdle belts) well-developed distally. Arm spines present before first fork. Madreporite usually one.

Gorgonocephalus chilensis (Philippi, 1858)

Figs 6.26 and 6.27.

Astrophyton chilense Philippi, 1858: 268.
Astrophyton pourtalesii Lyman, 1875: 28-29, pl. 4, figs 41-43.
Gorgonocephalus chilensis: Lyman, 1882: 261; Koehler, 1908b: 142; Clark, 1915a: 185; Clark, 1923: 318, Döderlein, 1927: 30-31; Zirpolo, 1932: 1-16, figs 1, 2; Mortensen, 1936: 240-241; Fell, 1958: 20; Seno and Irimura, 1968: 148-149; Monteiro and Tommasi, 1983: 33-54; McKnight, 2000: 45-46, fig. 20, pl. 19.
Gorgonocephalus pourtalesii: Lyman, 1882: 261-262, pl. 45.
Gorgonocephalus chilensis var. *novaezelandiae* Mortensen, 1924: 93, 109-110, pl. 4, fig. 1.

Diagnosis *- adapted from Lyman (1882) and McKnight (2000).*
D.D. up to 64mm. Disc slightly inflated, interradial areas slightly indented. Radial shields conspicuous, narrow, extend more or less to centre of disc, tapering at distal ends, densely covered in conical tubercles, mostly higher than wide, remainder of disc covered in skin with numerous scattered tubercles, sometimes smaller in size. Disc margin with few larger tubercles, forming continuous series with those of radial shields. Ventral interradial areas covered in skin with small, scattered, low tubercles, few scattered tubercles towards oral area. Oral shields triangular, covered in smooth skin, sometimes with few scattered tubercles, adoral shields square. Oral papillae and teeth spiniform, fringe oral frame, but absent in distal notches. Arms branched, flexible dorso-ventrally, forks *c.* ten times, rounded dorsally with small round or dome-shaped tubercles, proximal segments with naked plates. First fork at base of disc, approximately six segments between forks. Arm spines lacking on first arm segment, increasing to two on segment two and three, increasing again to four or five then decreasing to two or three from about fifth fork, spines shorter than the arm width, slightly flattened, pointed becoming multi-toothed hooks. Ventral arm surface flat, relatively smooth near base, becoming scattered with small tubercles. Genital slits short, wide. Genital papillae present, in series with disc papillae, large, usually higher than wide. Madreporite one, at edge of oral frame. Colour uniform creamy white, disc pale brown, arms, radial shields and tubercles cream (Baker, 1980; McKnight, 2000).

Distribution and habitat
New Zealand, Ross Sea, Falklands, Chile, (Philippi, 1858; Mortensen, 1924; Mortensen, 1936; Seno and Irimura, 1968; McKnight, 2000), South Africa: Cape Town (WC) to Port Edward (KZN); depth range: 22-900m.
Habitat: Mud, fine sand.

Remarks
Distribution here extended into southern KZN from Cape Town (see Table 7.3).

Clark (1923), Seno and Irimura (1968) and Mortensen (1936) reported that a number of specimens had younger individuals attached to them. Clark reported they were adults and were viviparous, while Mortensen (1933c; 1936) disputed this and suggested that the presence of smaller individuals on, or attached, to larger individuals has nothing to do with viviparity or brood protection, but was rather a function of the smaller individual using the larger animal in a similar way to gorgonians.

The type material is in the Museum of Comparative Zoology (syntype: MCZ OPH-2954), type locality off Cape Raso, Argentina, depth 100m.

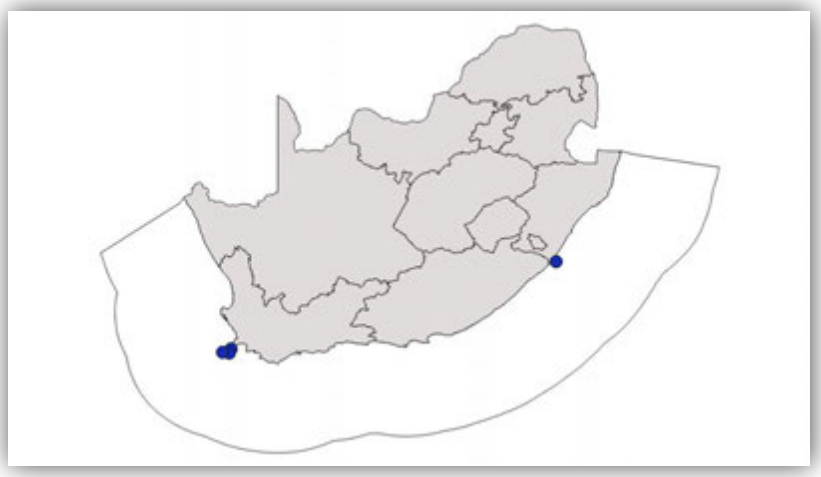

Figure 6.26. Distribution of *Gorgonocephalus chilensis* in South Africa.

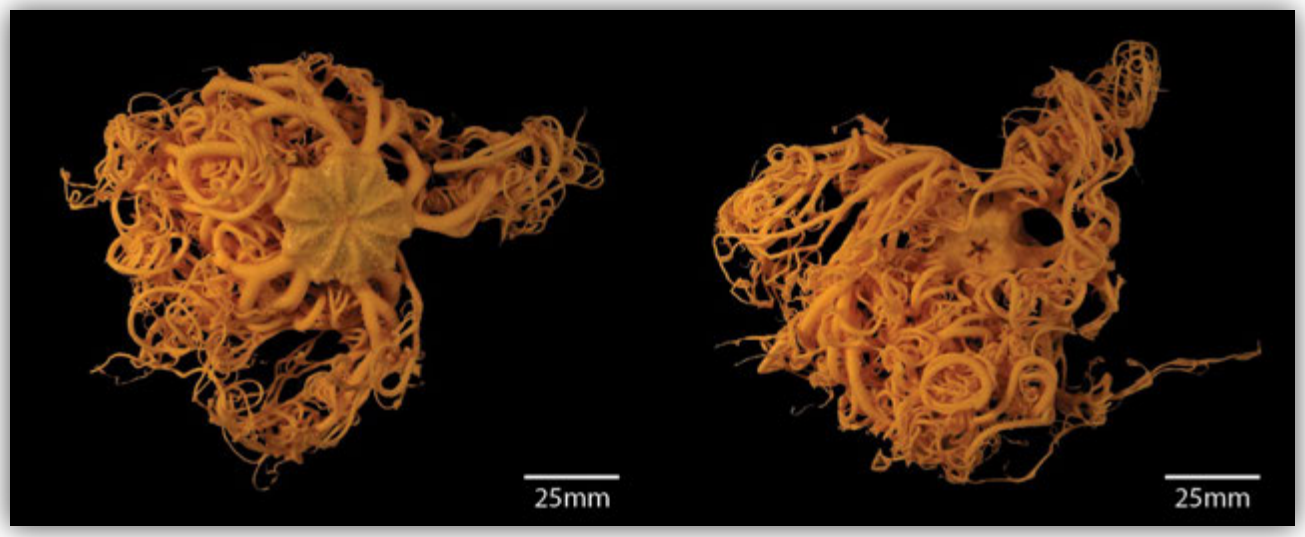

Figure 6.27. Dorsal (left) and ventral (right) views of *Gorgonocephalus chilensis* (SAMC A084240).

***Gorgonocephalus pustulatum* (Clark, 1916)**

Figs 6.28 and 6.29.

Astrodendrum pustulatum Clark, 1916: 84-85, pl. 34, figs 1, 2; Döderlein, 1927: 32-33, pl. 1, figs 5, 6; Clark, 1946: 181.
Gorgonocephalus moluccanus Döderlein, 1927: 26-27, pl. 2, fig. 2.
Gorgonocephalus pectinatus Mortensen, 1933c: 281-285, figs 16, 17, pl. 18, figs 1, 2; Clark and Courtman-Stock, 1976: 133, 100, 108, figs 86, 88.
Gorgonocephalus pustulatum: Baker, 1980: 54-56, fig. 20; Rowe and Gates, 1995: 368; McKnight, 2000: 49-51, pl. 21.

Diagnosis *- adapted from Mortensen (1933c), Baker (1980) and McKnight (2000).*
D.D. up to 54mm. Dorsal disc covering variable, some specimens naked interradially, while others with numerous tubercles, conical or almost spine-like, interradial areas excavate, disc margin of mostly thin, naked plates, sometimes with tubercles. Radial shields prominent, narrow, uniform in width, converge towards centre, tubercles irregular. Ventral surface flat, naked. Jaws with small low tubercles, with remaining area naked covered in skin. Oral papillae slender, spiniform, teeth stouter, with slightly flattened tips, papillae forming continuous fringe, but not within distal notches. Arms branched, flexible

dorso-ventrally, with at least eight forks, first fork just beyond disc, approximately 8-11 segments between forks, then between 10-33 segments between forks distally. Dorsal arms round, smooth and covered with fairly large irregular plates sometimes with tubercles. Ventral arms flat, smooth, with few, low scattered tubercles. Belts of hooks continuous from near the arm base, slightly raised above arm surface, hooklets with small secondary tooth. Arm spines begin on second arm segment, with segments 4-6 with two spines, and then 3-4 spines continuing down arm, only one spine distally. Spines short, cylindrical, blunt multi-pointed tips becoming multi-toothed hooks distally. Genital slits large, conspicuous, papillae slightly larger than disc tubercles, randomly spaced. Colour from deep pinkish-brown (Clark and Courtman-Stock, 1976) to dull brown, with the radial shields and ventral surface lighter or red (McKnight, 2000).

Distribution and habitat

Western Indian Ocean, Indonesia, Australia, New Zealand, West Pacific (Baker, 1980; Rowe and Gates, 1995), South Africa: Cape Town (WC) to Folokwe (EC); depth range: 78-860m.
Habitat: Fine sand, rock, rough substrata and one specimen attached to an anemone.

Remarks

The type material is in the Museum of Comparative Zoology (holotype: MCZ OPH-3952), type locality east of Flinders Island, Australia, depth 183-549m.

The differences between *Gorgonocephalus chilensis* and *G. pustulatum* are not obvious. Baker (1980) stated that tubercle density on the disc cannot be used as the single character to differentiate between Gorgonocephalid species. Since then, authors have put forward a variety of characters to differentiate between the two species, however, it seems that there still is no easy-to-use character to differentiate between them. Okanishi (2012) proposed that *G. pustulatum* had tubercles only on the radial shields, while *G. chilensis* also had tubercles scattered on the dorsal disc. In *G. pustulatum*, the dorsal interradial areas were relatively narrow with clusters of small granule-shaped epidermal ossicles. The interradial areas in *chilensis* are relatively wide, while the hooklets on the arms are discontinuous from the base of the arms.

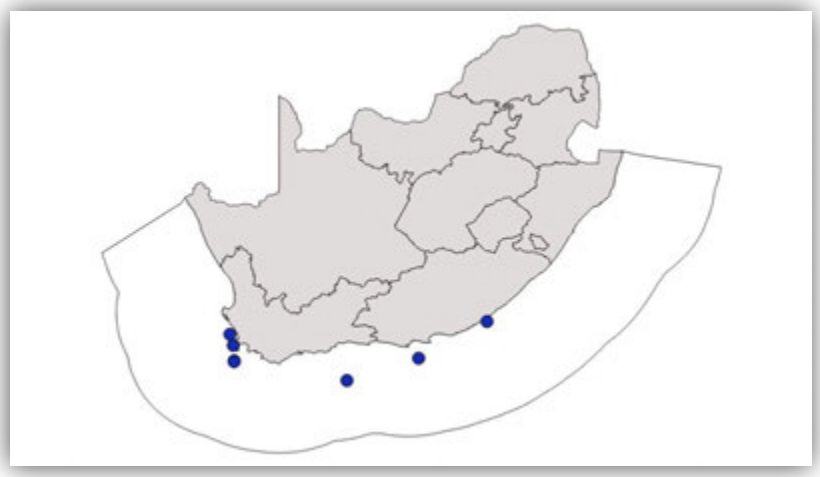

Figure 6.28. Distribution of *Gorgonocephalus pustulatum* in South Africa.

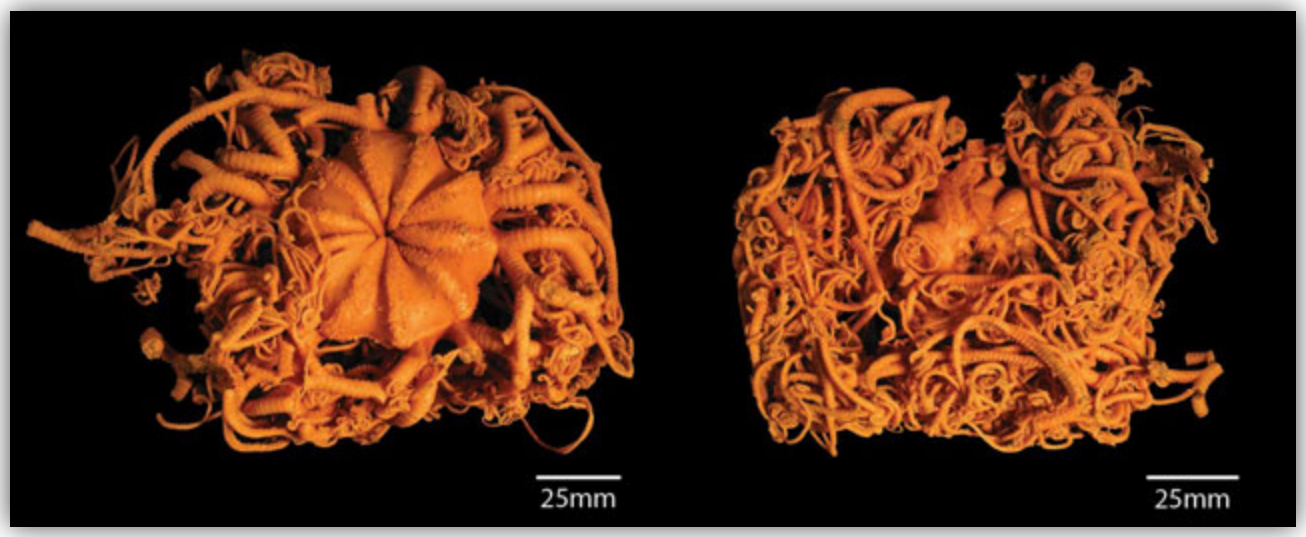

Figure 6.29. Dorsal (left) and ventral (right) views of *Gorgonocephalus pustulatum* (SAMC A084227).

Order Ophiurida Müller and Troschel, 1840

Suborder Ophiomyxina Fell, 1962

Family OPHIOMYXIDAE Ljungman, 1867

Diagnosis *- adapted from Matsumoto (1917).*
Disc moderate to large in size, covered with thick skin, sometimes with embedded scales visible when dried. Radial shields bar-like, flattened. Oral shields distinct, adoral shields sometimes fused. Arms simple, moderately long, slender, not markedly attenuated, covered in thick skin obscuring underlying plates. Dorsal arm plates fragile, fragmented or absent, ventral arm plates more entire and not always contiguous. Lateral arm plates with series of spines sometimes modified into hooks distally. Tentacle pores large, tentacle scale absent or single.

Genus Ophiomyxa **Müller and Troschel, 1842**

Diagnosis *- adapted from Müller and Troschel (1842) and Lyman (1882).*
Disc and arms covered in thick, naked skin with underlying plates. Radial shields flattened. Oral shields more or less distinct. Oral papillae usually very broad, finely serrated, glassy and flattened. Dorsal arm plates whole or fragmented. Arm spines stout, spiny, Tentacle scales absent.

Mortensen (1927) placed the type specimen of *Ophiodera serpentaria* (Lyman, 1883) into *Ophiomyxa*, thereby making *Ophiodera* the synonym of *Ophiomyxa*. Clark, A.H. (1952) ignored this synonymy and described a new species as *Ophiodera punctata*. According to Franklin and O'Hara (2008), regardless if the synonymy is accepted, there is some merit in the characters being shared, i.e. shape of oral plates and the long arm spines becoming serrated on distal segments, which have proved useful in identifying different species.

Ophiomyxa australis Lütken, 1869

Figs 6.30 and 6.31.

Ophiomyxa australis Lütken, 1869: 45, 98, 99; Lyman, 1882: 246; Koehler, 1907: 341, Benham, 1909: 101; Clark, 1915a: 168, pl. 1, figs 1-2; Clark, 1916: 77; Matsumoto, 1917: 19-21, fig. 3, pl. 1, figs 4-7; Clark, 1932: 203; Clark, 1938: 201, pl. 13, figs 1-21; Clark, H.L., 1939: 36-37; Clark, 1946: 170-171; Madsen, 1967: 141; Clark and Rowe, 1971: 78, 92-93, pl. 13, figs 3, 4; Devaney, 1974: 115-116; Cherbonnier and Guille, 1978: 18-19, pl. 3, figs 1, 2; Sloan *et al.*, 1979: 99, figs 5, 6; Irimura, 1982: 2-4, fig. 1; Guille and Vadon, 1985: 62; Marsh, 1986: 70; Sastry, 1991: 375-376; Liao and Clark, 1995: 155, fig. 64; Rowe and Gates, 1995: 406; Mbongwa, 2013: 15; Olbers *et al.*, 2015: 89, pl. 1E, F.
Ophiomyxa brevispina Von Martens, 1870: 249-50; De Loriol, 1893b: 425-426; Döderlein, 1896: 298, pl. 17, fig. 27; Koehler, 1905a: 119; Clark, 1915a: 170, pl. 1, figs 1, 2; Koehler, 1930: 48.
Ophiomyxa robillardi De Loriol, 1893a: 53-54, pl. 25, fig. 5.
Ophiomyxa brevispina var. *irregularis* Koehler, 1898b: 111-112.
Ophiomyxa irregularis Koehler, 1905a: 119-120, pl. 12, fig. 1; Koehler, 1922b: 17-20, pl. 2, fig. 18, pl. 5, figs 1, 2, pl. 6, fig. 4, pl. 92, fig. 2; Koehler, 1930: 48.

Diagnosis - *adapted from Cherbonnier and Guille (1978).*

D.D. up to 23mm. Disc pentagonal, covered with thick, opaque, smooth skin. Radial shields short, narrow, separated by width of arm base. Row of overlapping scales along disc margin. Genital slits bordered by plates similar to ones on disc margin, long, narrow. Oral shields oval, triangular, covered by thick skin, longer than wide, abutting genital slit. Oral papillae three, broad, serrated, flattened and transparent on edges. Teeth similar. Arms five, covered in thick, naked skin. Arm spines up to seven, one on segment one, then two and four on first free arm segments. Arm spines slender, serrated and rugose at tip, some becoming curved or slightly hooked. Dorsal arm plates irregular, fragmented, becoming less fragmented distally. Ventral arm plates distinctly wider than long, deep notch on distal side, not contiguous distally. True tentacle scales absent, tube of ossicles surrounding tube foot present. Colour in life blood-red dorsally and ventrally, arms lightly banded with yellow.

Distribution and habitat

East Africa and associated Islands, Madagascar, Mascarene Basin, Red Sea, Seychelles, New Zealand (Stöhr, 2007d), Indo-West Pacific (Rowe and Gates, 1995), South Africa: Mbashe River (EC) to Dog Point (KZN); depth range: 11-75m.
Habitat: In sand, grey ooze, coral, stones, gravel, mud, sandstone rubble, gorgonians.

Remarks

First reported in South Africa by Olbers *et al.* (2015). According to Rowe and Gates (1995), the type locality is Bass Strait (as '... inter Australian et Tasmaniam') with the syntypes in the Natural History Museum of Denmark (ZMUC OPH-474), depth unknown.

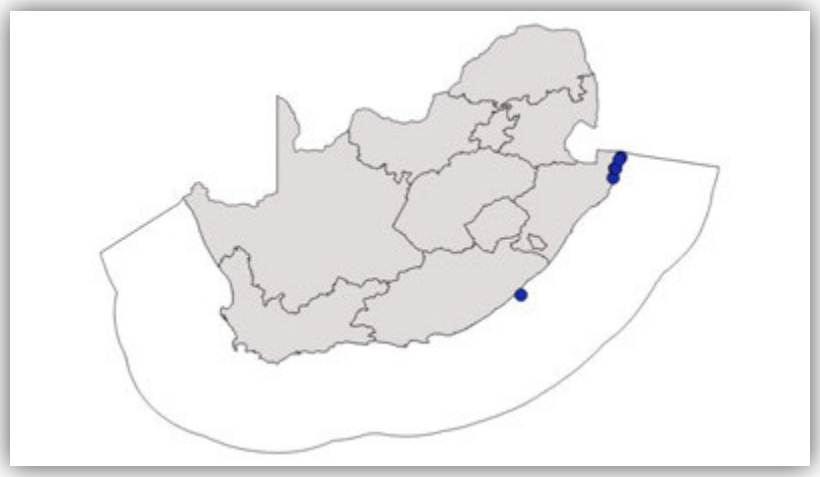

Figure 6.30. Distribution of *Ophiomyxa australis* in South Africa.

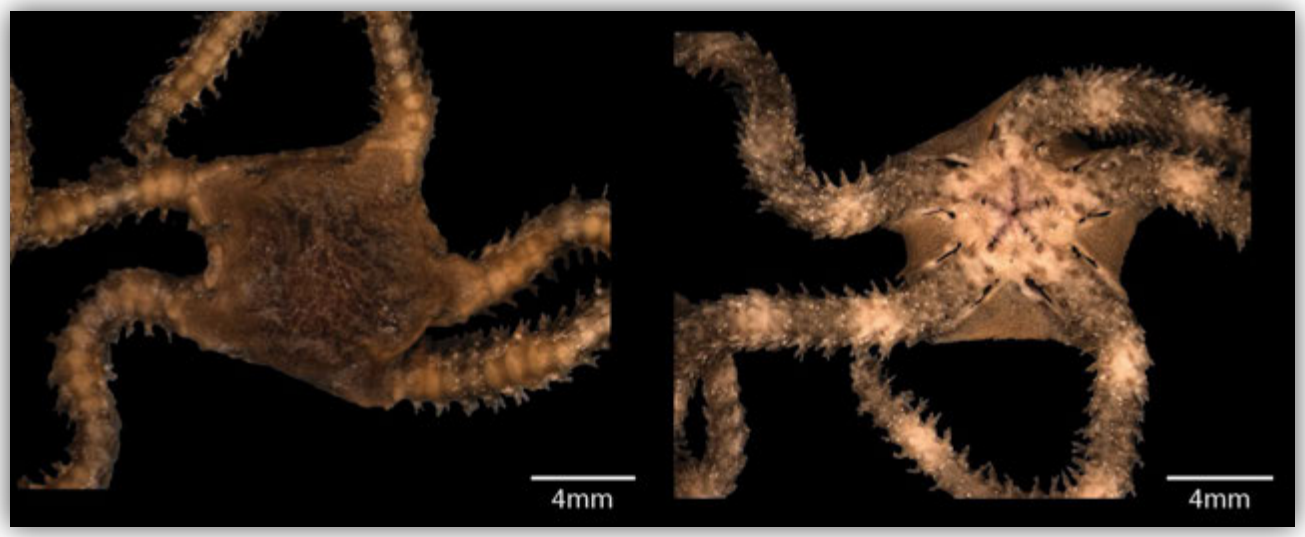

Figure 6.31. Dorsal (left) and ventral (right) views of *Ophiomyxa australis* (RMCA MT2274).

***Ophiomyxa bengalensis* Koehler, 1897**

Figs 6.32 and 6.33.

Ophiomyxa bengalensis Koehler, 1897: 363-364, pl. 9. figs 70, 71; Koehler, 1922b: 17, pl. 5, figs 5, 6; pl. 92, fig. 1; Koehler, 1930: 48; Mortensen, 1933c: 306-309, fig. 31; Clark and Courtman-Stock, 1976: 134, 111, figs 98, 101.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 30mm, D.D./A.L. = 1/6-7. Disc pentagonal, covered with thick skin with white embedded ossicles, giving the disc a speckled appearance. Radial shields shorter than width of arm base, narrow. Oral shields oval, with distal lobe. Adoral shields narrow, not contiguous. Oral papillae 3-4, most pointed or rarely broad, serrated, flattened, some tapering to a point and transparent on edges. Teeth broad, serrated and translucent on edges. Dorsal arm plates whole, much longer than wide. Ventral arm plates equally wide and long, with deep distal notch. Arms simple, five, long, covered in thick skin. Arm spines 3-4, long, slender, serrated and rugose at tip, uppermost spine stout, one spine on first two segments, then two spines and 3-4 on free segments. Genital slits long, narrow, approximately three-quarters length of interradial area, bordered by long plates. Tentacle scales absent. Colour in life red to orange.

Distribution and habitat
Andaman Islands, China Sea, Kei Islands (Koehler, 1922b; Koehler, 1930), South Africa: Treasure Beach (KZN) to Amatikulu (KZN); depth range: 33-1 962m.
Habitat: Grey fine mud.

Remarks
The two specimens on hand were from a trawler and were quite damaged. This is the only ophiomyxid in South Africa that has pointed oral papillae and an oral shield with a distal lobe, absent in *O. tenuispina* and *O. australis*. The location of the type material is unknown, but the type locality is Andaman Islands, India, depth 316-457m (Clark and Courtman-Stock, 1976).

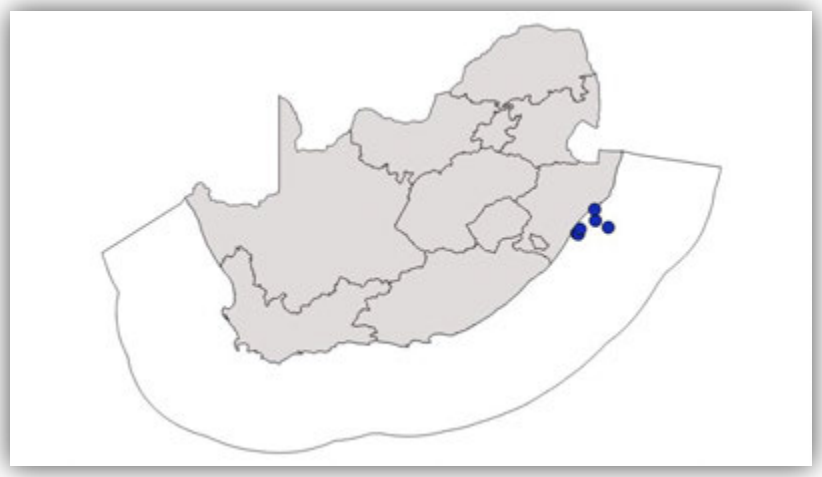

Figure 6.32. Distribution of *Ophiomyxa bengalensis* in South Africa.

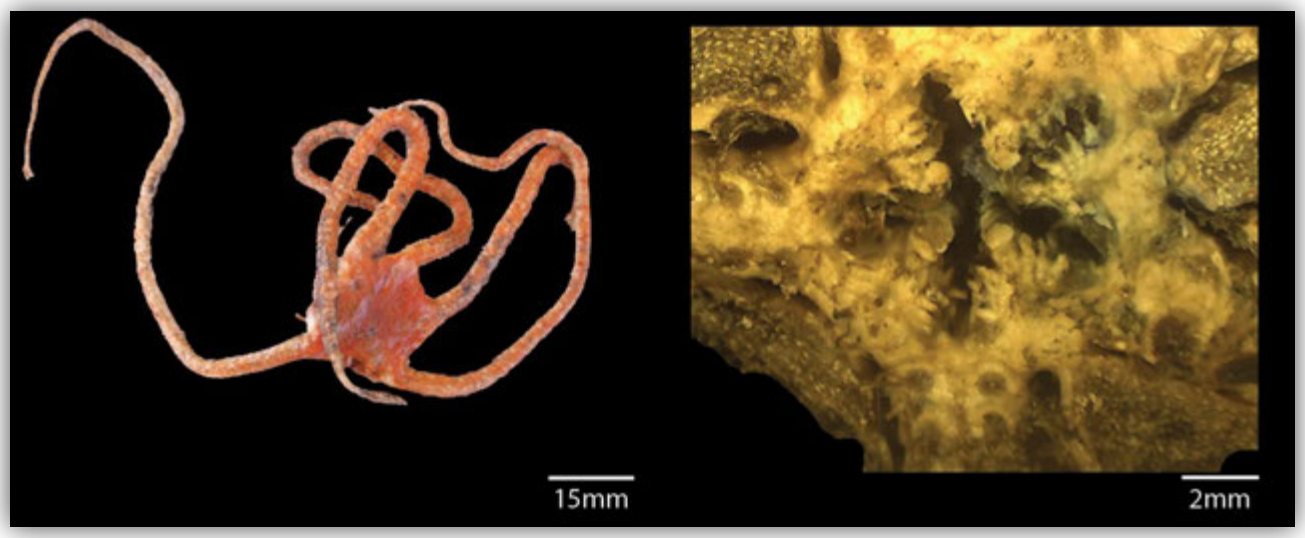

Figure 6.33. Dorsal (left) and ventral (right) views of *Ophiomyxa bengalensis* (SAMC A084233).

Ophiomyxa tenuispina Mortensen, 1933
Figs 6.34 and 6.35.

Ophiomyxa tenuispina Mortensen, 1933c: 304-306, fig. 30, pl. 19, fig. 27; Clark and Courtman-Stock, 1976: 134, 111, figs 99, 100, 101.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 11mm. Disc pentagonal, covered with thick, smooth, naked skin; disc margin with row of marginal scales. Radial shields just shorter than arm base width, narrow, cigar-shaped. Oral shields oval to diamond-shaped. Adoral shields contiguous. Oral papillae 3-4, broad, serrated, flattened and transparent on edges. Teeth similar. Arms simple, five, covered in thick skin. Arm spines 4-5 (not alternating) on free segments, slender, serrated and rugose at tip. One arm spine on first segment, then two on segments two and three, increasing to five on free segments. Dorsal arm plates wider than long, fragmented with two adjacent plates. Ventral arm plates wider than long, with deep distal notch. Genital slits two-thirds interradial length. Tentacle scales absent. Colour greenish, arms banded.

Distribution and habitat
South Africa: off Haga Haga (EC) to Dog Point (KZN); depth range: 74-260m.
Habitat: Rock, sandstone rubble, gorgonians, stones, sponges.

Remarks
Endemic to South Africa (see Table 7.4). *O. tenuispina* and *O. australis* are the only South African species that have fragmented dorsal arm plates. The holotype is in the Natural History Museum of Denmark (ZMUC OPH-288), type locality is north east of East London, depth 174m.

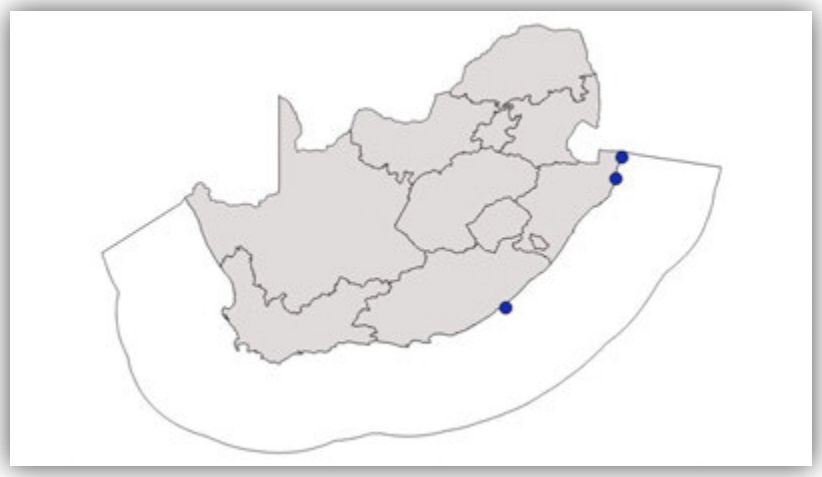

Figure 6.34. Distribution of *Ophiomyxa tenuispina* in South Africa.

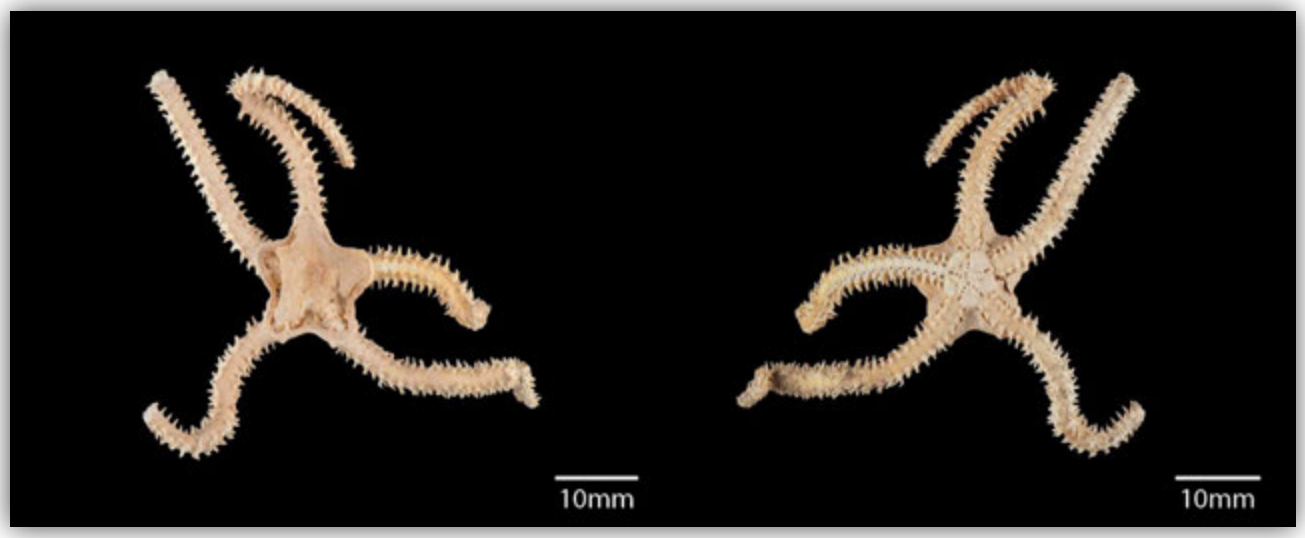

Figure 6.35. Dorsal (left) and ventral (right) views of *Ophiomyxa tenuispina* (ZMUC OPH-288).

Ophiomyxa vivipara capensis Mortensen, 1936

Figs 6.36 and 6.37.

Ophiomyxa vivipara Studer, 1876: 462; Lyman, 1882: 246; Clark, 1915a: 170, pl. 2, figs 1, 2; Clark, 1923: 313; Mortensen, 1933c: 301-404, figs 27-29.
Ophiomyxa vivipara capensis Mortensen, 1936: 242; Clark, A.M., 1952: 199; Clark and Courtman-Stock, 1976: 134, 101, 111, figs 101, 102; Alva and Vadon, 1989: 828-829, 832.

Diagnosis *- adapted from Mortensen (1936) and Clark and Courtman-Stock (1976).*
D.D. up to 23mm, disc pentagonal. Disc covered with thick, opaque, smooth skin. Radial shields short, narrow, just shorter than arm base width. Oral shields oval with broad distal lobe, longer than wide, abutting the genital slit. Adoral shields not contiguous, narrow. Oral papillae 3-4, broad, serrated, flattened with transparent edges. Teeth similar, 4-5. Arms simple, five, covered in thick naked skin. Tentacle oral scales two, sharp, deep in mouth. Arm spines slender, serrated and rugose at tip, up to four on free segments. One spine on segments 1-5. Dorsal arm plates delicate, whole, with small pits visible, wider than long proximally, then equally wide as long, with distal notch. Ventral arm plates equally wide as long or slightly longer, distally notched and proximal edge straight. Genital slits bordered by long, narrow plates, approximately two-thirds of interradial areas length. Tentacle pores large, tentacle scales absent.

Distribution and habitat
South Africa: off Orange River (NC) to East London (EC); depth range: 101-450m.
Habitat: Sand, mud, rock, coral, clay and rough bottom.

Remarks
Endemic to South Africa (see Table 7.4). According to Mortensen (1936), the only difference between *O. vivipara* (the Magellanic form) and *O. vivipara* var*. capensis* is that the variety has one spine up to the fifth or sixth segment, while the Megellanic form has two spines from the third or fourth segment. Clark and Courtman-Stock (1976) disputed that this could be used as a difference, but did agree that there was a zoogeographical subspecific difference and retained it as the subspecies *O. vivipara capensis*. A number of specimens within Iziko South African Museum were labelled as *O. vivipara*, these were examined and changed to *O. vivipara capensis* based on the arm spine arrangement described above.

The dorsal arm plates on the ophiomyxids should be carefully examined, as they can break easily, making the plates appear to be fragmented. Mortensen (1924) stated that the dorsal arm plate configuration in *O. vivipara* is a single plate which is thin, delicate and fenestrated, whereas in *O. australis* and *O. brevirima,* the dorsal arm plates are fragmented.

Type material is in the Museum of Natural History at the University of Berlin (syntype of *Ophiomyxa vivipara*: ZMB Ech 2193) and the type locality is Argentina, depth unknown.

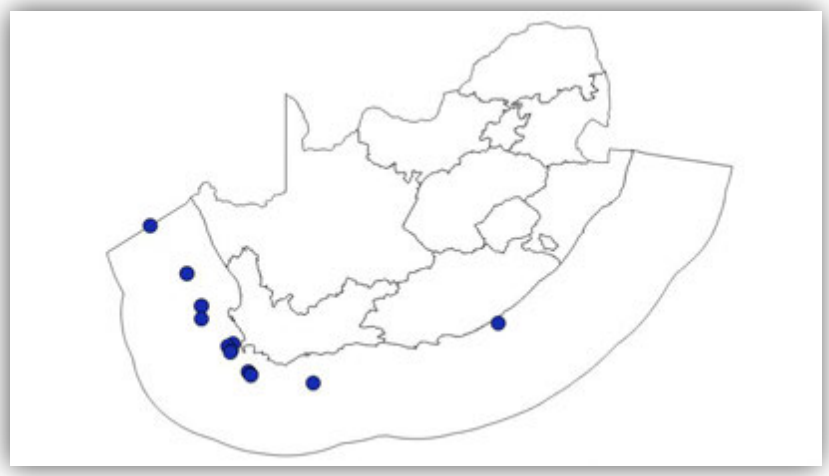

Figure 6.36. Distribution of *Ophiomyxa vivipara capensis* in South Africa.

Figure 6.37. Dorsal (left) and ventral (right) views of *Ophiomyxa vivipara capensis* (SAMC A082574).

Genus *Ophiolycus* Mortensen 1933

Diagnosis *- adapted from Mortensen (1933c) and Martynov (2010).*
Disc covered in skin. Radial shields moderately developed, elongated, genital slits long; genital plates bordering about two-thirds of slits. Oral papillae spiniform, similar in shape to the cluster of teeth. Oral tentacle scales, almost in series with oral papillae. Oral shield oval to rhomboidal, indistinct distal lobe. Adoral shields bilobed distally, very narrow proximally. Dorsal arm plates moderately developed, sometimes fragmented. Ventral arm plate well defined. Arm spines relatively long, flattened, distally transformed into hooks. Tentacle scale absent or small.

Ophiolycus dentatus (Lyman, 1878)

Figs 6.38 and 6.39.

Ophioscolex dentatus Lyman, 1878: 157, pl. 7, figs 184-186; Lyman, 1882: 233, pl. 24, figs 4-6; Bell, 1905: 259; Clark, 1923: 314; Clark, A.M., 1952: 199.
Ophioscolex (Ophiolycus) dentatus: Mortensen, 1933c: 309-312, figs 32-34; Clark and Courtman-Stock, 1976: 101, 111, 135, fig. 104; Alva and Vadon, 1989: 832-833.
Ophioscolex dentatus var. *spiniger* Mortensen, 1933c: 312-313, fig. 35.

Ophiolycus dentatus: Martynov, 2010: 104, fig. 71a-h, fig. 72.

Diagnosis *- adapted from Lyman (1878), Lyman (1882), Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 23mm, disc covered in thick skin dorsally and ventrally, small spines on dorsal disc. Radial shields narrow, just shorter than width of arm base. Oral shields oval, with broad distal lobe. Adoral shields contiguous, moderately narrow, with two spines, one in sequence with oral papillae. Oral papillae spiniform, long. Teeth similar in shape, but smaller and clustered at apex of jaw. Genital slits long, narrow. Genital plates present but not along entire length of slit. Arms five, simple, length moderate. Dorsal arm plates fragmented especially basally, but varied along length of arm, with no apparent pattern. Ventral arm plates distinct, equally as wide as long basally and contiguous, becoming longer than wide and not contiguous. Arm spines three, lowermost cigar-shaped, broad and flattened, approximately one segment length, remaining spines spiniform, uppermost being slightly longer than segment length, spines becoming hook-shaped distally. Tentacle pores large. Tentacle scales one, spiniform, small.

Distribution and habitat
Namibia, South Africa: off Groen River (NC) to Sodwana Bay (KZN); depth range: 129-450m.
Habitat: Rock, black speckled sand, shell and mud.

Remarks
Specimens examined from Iziko South African Museum were all labelled as *Ophioscolex dentatus* var. *spiniger* Mortensen, 1933. See remarks on *Ophiolycus* under *Ophioscolex inermis*. The syntype is in the Natural History Museum of Denmark (ZMUC OPH-284), type locality Agulhas Banks, depth 275m.

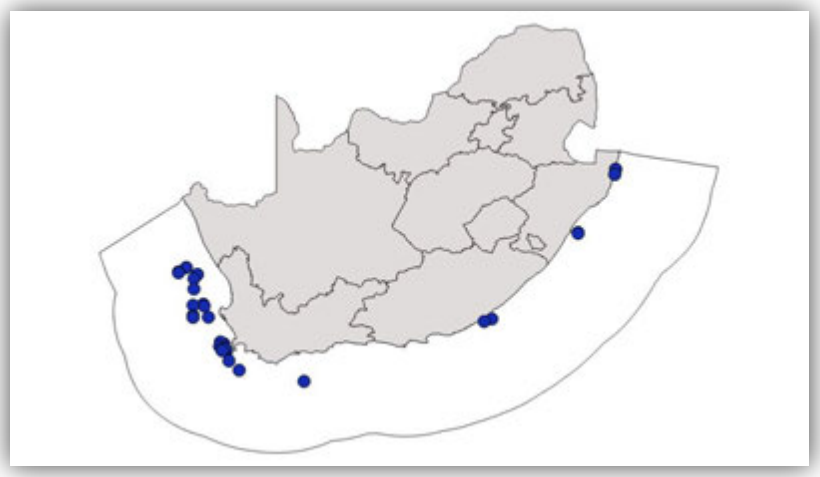

Figure 6.38. Distribution of *Ophiolycus dentatus* in South Africa.

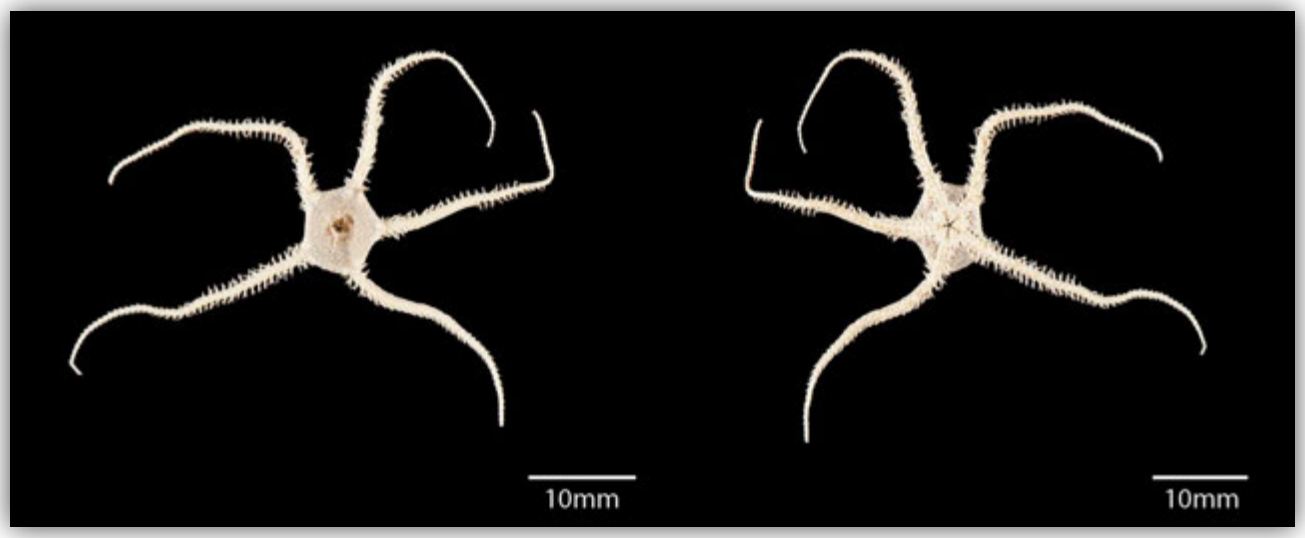

Figure 6.39. Dorsal (left) and ventral (right) views of *Ophiolycus dentatus* (ZMUC OPH-284).

Genus Ophioscolex Müller and Troschel, 1842

Diagnosis - *adapted from Müller and Troschel (1842) and Martynov (2010).*
Disc covered in thick skin, small scales visible when dried, radial shields small, triangular, hardly conspicuous, genital slits long, conspicuous, genital plates border only distalmost part of slit. Oral papillae spiniform, teeth similar in shape, clustering. Oral shields vary in shape, with or without distinct distal lobe, adoral shields similar in size, slightly widened distally. Dorsal arm plates conspicuous in *O. inermis* only, ventral arm plates well-defined. Arm spines relatively long, conical, with or without hooks, tentacle scales absent or small, oval or spiniform.

Ophioscolex inermis Mortensen, 1933

Figs 6.40 and 6.41.

Ophioscolex inermis Mortensen, 1933c: 313-315, fig. 36; Martynov, 2010: 108, 111.
Ophioscolex (*Ophioscolex*) *inermis*: Clark and Courtman-Stock, 1976: 136, 101, 111, fig. 103.

Diagnosis - *adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 8mm. Dorsal disc covering unknown. Oral shields small, rounded semi-circular inner edge, straight or slightly concave outer edge. Adoral shields large, contiguous radially. Oral papillae spiniform, slender, small, apex of jaw with cluster of papillae which are slightly longer. Oral tentacle pore not within mouth slit. Dorsal arm plates thin, transparent, broadly contiguous, distally convex, some appear to be split transversely into two parts. Ventral arm plates slightly longer than wide, distal edge flat or slightly concave. Arm spines three, long, slender, glassy, lowermost club-shaped. Tentacle scales absent.

Distribution and habitat
South Africa: Durban (KZN) to off Tugela River mouth (KZN); depth range: 366-412m.
Habitat: Sandy mud.

Remarks
No specimen was examined during this study, but known to be endemic to South Africa (see Table 7.4). According to Mortensen (1933c) and Clark and Courtman-Stock (1976) there is only one

collected specimen of this species. However, a second specimen was located in the Smithsonian Institution, but no photos were available to examine the dorsal disc (Dave Pawson, pers. comm.). The holotype is in the Natural History Museum of Denmark (ZMUC OPH-126), type locality off Durban, depth 412m.

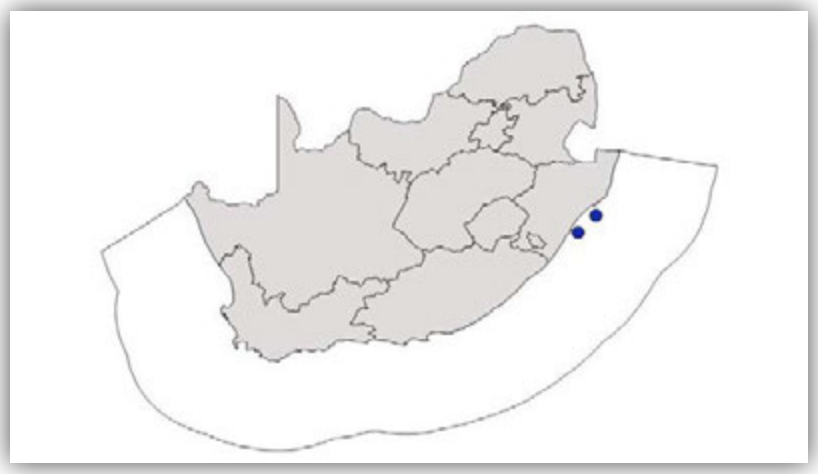

Figure 6.40. Distribution of *Ophioscolex inermis* in South Africa.

Figure 6.41. Dorsal (left) and ventral (right) views of *Ophioscolex inermis* (ZMUC OPH-126).

Suborder Ophiurina Müller & Troschel, 1840

Infraorder Chilophiurina (Matsumoto, 1915)

Family OPHIURIDAE Lyman, 1865

Diagnosis *- adapted from Spencer and Wright (1966) and Clark and Courtman-Stock (1976).*
Disc covered in thick scales or plates, primary rosette mostly conspicuous. Radial shields stout. Genital papillae usually present. Oral papillae few in number, in series. Dental papillae absent. Single infradental papillae. Arms moderate to short in length, widest at base, tapering, slightly flattened in cross section. Dorsal and ventral arm plates small, well-developed, basal plates sometimes contiguous. Lateral arm plates dominate towards distal portion of arm. Arm spines short, appressed to arm, upper ones sometimes longer than segment. Tentacle pores small for entire arm, if large

restricted to disc. Tentacle scales either semi-circular, multi-papilliform or squamiform, may reduce along arms and become absent distally.

Genus Ophiernus Lyman, 1878

Diagnosis *- adapted from Lyman (1878) and Madsen (1977).*
Disc bearing granules on thick skin. Radial shields usually naked and conspicuous. Arms long and more-or-less flattened. Dorsal arm plates well-developed, contiguous, in some species 3-6 proximal-most plates form triangular-shaped areas covered in skin. Ventral arm plates whole, contiguous. Arm spines small, smooth. In the South African species, only *O. vallincola* has the bristle-like supplementary arm spines, distally directed, appressed and placed in a furrow along the thickened edge of the lateral edge on the lateral arm plate characteristic of the genus. Adoral shields broadly separate oral shields from lateral arm plates and usually contiguous with lateral arm plates. Tentacle pores large, first pair within disc with three scales. Tentacle scales two, in series with three from first tentacle pores, may or may not completely cover tentacle pores. Genital slits long.

Ophiernus quadrispinus Koehler, 1908

Figs 6.42 and 6.43.

Ophiernus quadrispinus Koehler, 1908a: 533, 601-602; pl. 10, figs 102, 103; Koehler, 1908b: 142, 146; Madsen, 1977: 120-121, fig. 7; Billett *et al.*, 2013: 20-25; Olbers *et al.*, 2015: 89, 91, pl. 2A, B.

Diagnosis *- adapted from Madsen (1977).*
D.D. up to 7mm. Disc pentagonal, covered in scales both dorsally and ventrally, scales abutting radial shields and genital slits slightly larger. Sparse granules on disc margin extending onto margins of radial shields. Radial shields large, oval, longer than wide, separated by disc scales. Oral shields spearhead-shaped, naked. Adoral shields not distinct, extending up to first ventral arm plate, may or may not be contiguous proximally. Jaws long. Oral papillae 5-6, including two smaller papillae in series with scales around second oral pore. Teeth 3-4, tapering to blunt point. Genital slits as long as interradial area, genital papillae absent. Ventral arm plates bell-shaped, first plate sunken, contiguous proximally, becoming reduced and separated distally. Dorsal arm plates wider than long, distal edge straight proximally, becoming convex distally. Lateral arm plates increasing in size distally, with hosting arm spines. Arm spines four, delicate, cylindrical, pointed, shorter than segment length, decreasing distally. Arm spines placed on mid-plate proximally, moving dorsally distally, upper bristle-like arm spines absent. Arms moderately long (all specimens broken), dorsal arm with slight keel. Tentacle scales two, sometimes one, varying in shape from pointed to round, unequal in size.

Distribution and habitat
Southern Ocean, Southern Atlantic, near the South Orkneys (Madsen, 1977; Billett *et al.*, 2013), South Africa: off Saldanha Bay (WC) to off Cape Town (WC); depth range: 1700-3250m (Madsen, 1977). Habitat: no details recorded.

Remarks
Similar to *O. vallincola* Lyman, 1878 except in disc granules, dorsal arm plates and the absence of bristles. The granules are less dense adjacent to radial shields and the dorsal arm plates much wider than long in *quadrispinus*. The most obvious difference is the absence of bristles on the lateral arm plates on *vallincola*. Type material whereabouts unknown, type locality is Southern Ocean (Koehler, 1908a), depth unknown.

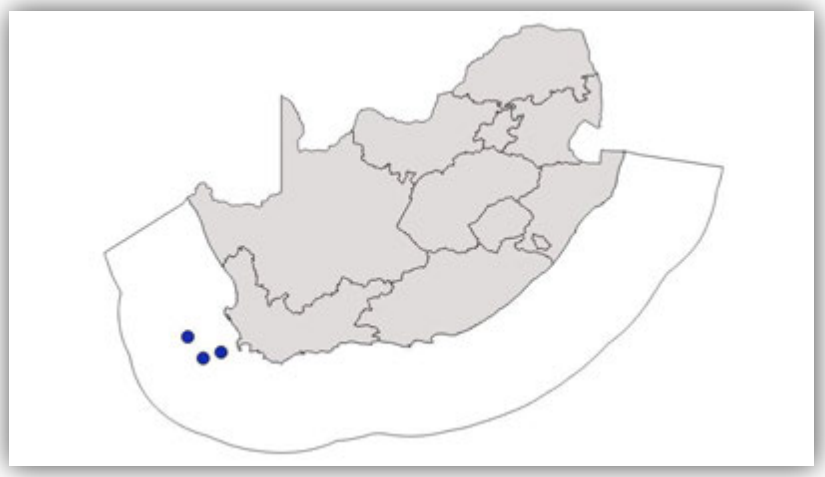

Figure 6.42. Distribution of *Ophiernus quadrispinus* in South Africa.

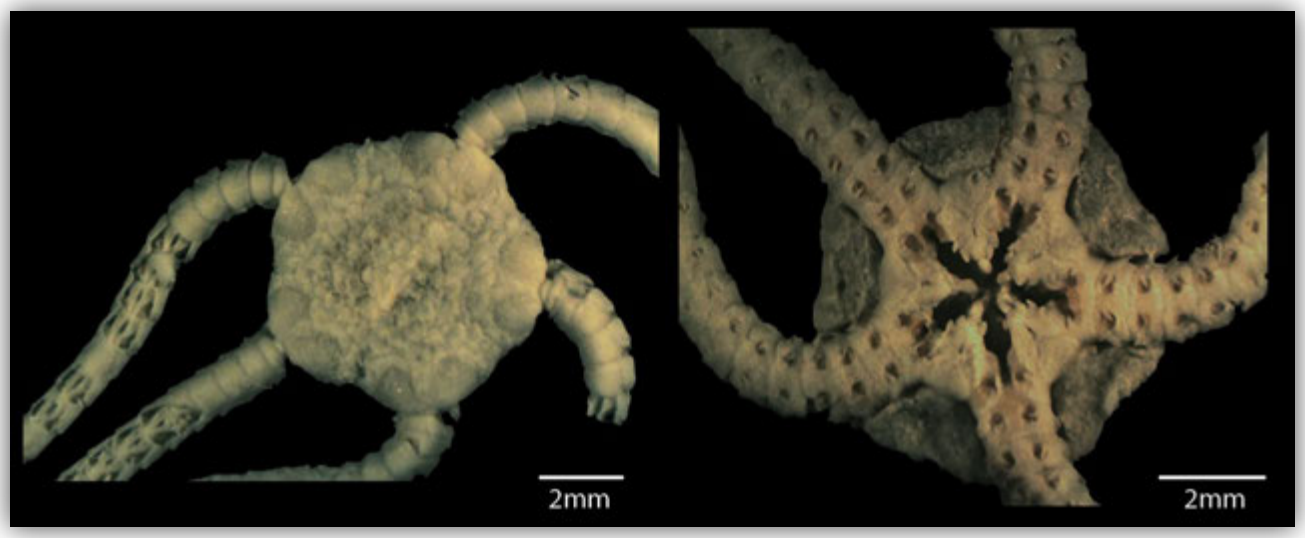

Figure 6.43. Dorsal (left) and ventral (right) views of *Ophiernus quadrispinus* (SAMC A22018).

***Ophiernus vallincola* Lyman, 1878**

Figs 6.44 and 6.45.

Ophiernus vallincola Lyman, 1878: 122, pl. 6, figs 170-172; Lyman, 1882: 32. pl. 24, figs 16-18, pl. 38, figs 6-9; Koehler, 1896a: 244; Clark, 1923: 365; Hertz, 1927a: 114; Madsen, 1977: 112-114, fig. 2; Clark and Courtman-Stock, 1976: 185, 106, 124, fig. 201; Baker, 1979: 33; Paterson, 1985: 98-99, fig. 40a, b; Rowe and Gates, 1995: 403; Mah *et al.*, 2009: 397; Martynov, 2010: 130, figs 5g, r, 11h.
Ophiernus abyssalis Koehler, 1896a: 242-244; Koehler, 1909b: 138, 143-145, pl. 28, figs 3-4.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. 5-20mm. Disc round, skin naked, scales on periphery of disc around radial shields developed with granules extending onto margins of radial shields. Radial shields distinct, separated, oval or round with proximal edge tapering slightly. Ventral interradial areas have few scattered minute granules (not all specimens). Oral shields spearhead-shaped, naked. Adoral shields not distinct, extending up to first ventral arm plate, may or may not be contiguous proximally. Jaws moderately long. Oral papillae 5-6, including two smaller papillae in series with scales around second oral pore. Teeth 3-4, lowest sometimes tapering to blunt point. Ventral arm plates bell-shaped, first plate sunken, contiguous proximally becoming reduced and separated. Dorsal arm plates wider than long, distal edge straight proximally becoming convex. Lateral arm plates increasing in size distally, hosting arm spines. Arm

spines three, cylindrical, pointed, longest spine as long as ventral arm plate, but generally shorter than a segment. Arm spines placed on mid-plate proximally, moving dorsally distally. Bristles present on dorsal side above arm spines. Arms moderately long, dorsal arm with slight keel. Genital slits almost as long as interradial area, with distinct genital plate distally, no genital papillae. Tentacle scales two, seldom three, rounded, equal in size, some distal scales pointed.

Distribution and habitat

Mozambique, Atlantic Ocean, Pacific Ocean, south west Ireland, Bay of Biscay and Azores (Mortensen, 1933d, Paterson, 1985), South Africa: off Saldanha Bay (WC) to off Cape Town (WC); depth range: 460-4 065m.
Habitat: Green mud.

Remarks

The granules on the disc and radial shields were not distinct on the specimens examined, however, Clark and Courtman (1976) did state that the granules are easily rubbed off. The type locality is west of Azores at 1830m depth. Syntypes in the Museum of Comparative Zoology, MCZ OPH-397 (2 specimens) and MCZ OPH-844 (2 specimens) (Rowe and Gates, 1995).

Figure 6.44. Distribution of *Ophiernus vallincola* in South Africa.

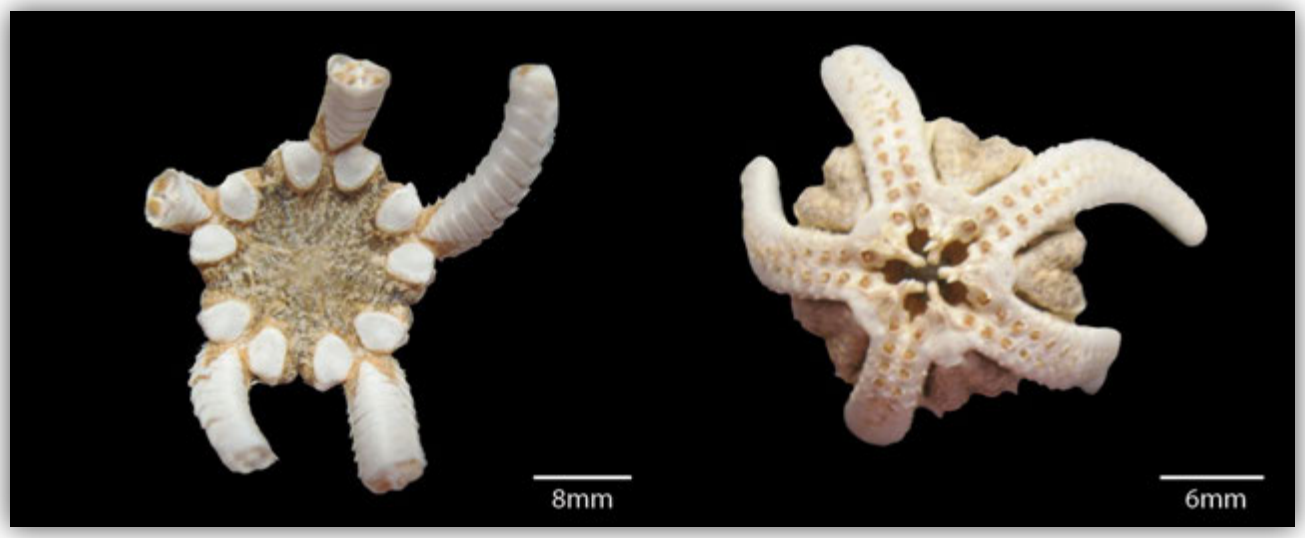

Figure 6.45. Dorsal (left) and ventral (right) views of *Ophiernus vallincola* (SAMC A7539).

Genus Ophiopallas Koehler, 1904

Diagnosis *- adapted from Koehler (1904a) and Madsen (1983).*
Dorsal disc covered in granules. Dorsal arm plates well-developed, widely in contact. Ventral arm plates contiguous. Arm spines 2-8, minute, comb-like accessory arm spines. Tentacle pores with 1-2 flat tentacle scales. Genital slit extending up onto dorsal side with papillae.

Ophiopallas paradoxa Koehler, 1904

Figs 6.46 and 6.47.

Ophiopallas paradoxa Koehler, 1904a: 12-13, pl. 3, figs 1-3; Clark, 1915a: 348; Koehler, 1922b: 436-437, pl. 79, figs 1, 2; Koehler, 1930: 280; Clark, 1974: 477-478, fig. 15; Clark and Courtman-Stock, 1976: 106, 124, 186, figs 199, 203; Baker, 1979: 32, 34, fig. 4c; Madsen, 1983: 54-57, figs 1e, f, 10a, b, 11; Liao and Clark, 1995: 288, fig 161; Rowe and Gates, 1995: 404; O'Hara, 2008: 30; Mah *et al.*, 2009: 397; Martynov, 2010: 38, fig. 26i, j; Stöhr, 2011a: 28, fig. 11d.
Ophiopallas paradoxa altera Hertz, 1927a: 110, pl. 9, fig. 5.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. = 4-6mm. Disc round, covered in granules dorsally and ventrally, extending onto radial shields. Radial shields moderate in size, triangular with round corners, radial shield margins contiguous, but concealed by disc scaling. Oral shields very large, naked, longer than wide, indented laterally just over midway, with broad distal lobe. Adoral shields not distinct, not contiguous, narrow. Few scattered granules on jaws. Oral papillae 4-6, distalmost large and opercular in series with second oral tentacle scale, apical papillae sometimes paired. Teeth two, equal in size and shape as apical papillae. Genital slits long, elongated and reach up onto dorsal disc, genital papillae present, slightly elongated, continuous with the granules on the disc. Arms flattened ventrally and have keel dorsally, tapering. Dorsal arm plates wider than long, becoming longer than wide distally, distal edge straight or slightly rounded, contiguous, granules extend onto first dorsal arm plate. Ventral arm plates rectangular but restricted on sides by tentacle pores, distal edge convex. Arm spines up to eight, slender, uppermost up to one-and-a-half times segment length, lowermost shortest, *c.* half as long as segment. Tiny accessory arm spines from segments 15 present, comb-like, glassy, curved, bifurcate and can only be seen at high magnification. Tentacle scales large, oval, one except on first segment, where there are two.

Distribution and habitat
New Zealand, Australia, East Indies, Indonesia, Philippines, Mozambique (Koehler, 1904a; Clark, 1915a; Hertz, 1927a; Koehler, 1930; Clark, 1974; Clark and Courtman-Stock, 1976; Baker, 1979; Madsen, 1983; Liao and Clark, 1995; Rowe and Gates, 1995; Mah *et al.*, 2009), South Africa: Sodwana Bay (KZN); depth range: 200-500m.
Habitat: Coarse shelly sand.

Remarks
Single South African specimen found at Sodwana Bay. The specimen examined was in poor condition with the highest arm spine count being five.

The type locality is Macassar (between Celebes and Borneo), Gilolo Passage (New Guinea) and Banda Sea (Indonesia) (Rowe and Gates, 1995) with the lectotype being designated by Madsen (1983) as Siboga Station 159, Banda Sea, depth 411m. Type material is in the Zoological Museum Amsterdam (now Naturalis) (ZMA.ECH.O.2435; ZMA.ECH.O.2436; ZMA.ECH.O.2437; ZMA.ECH.O.2438; ZMA.ECH.O.2439 and ZMA.ECH.O.2440; Joke Bleeker, pers. comm.).

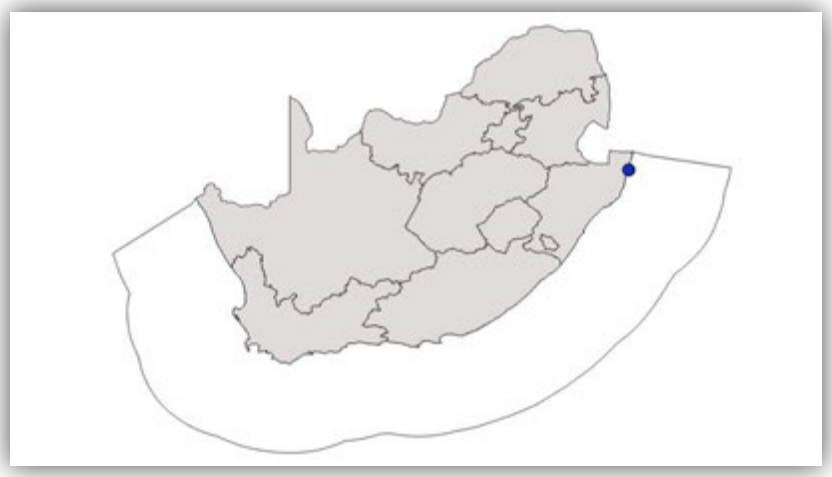

Figure 6.46. Distribution of *Ophiopallas paradoxa* in South Africa.

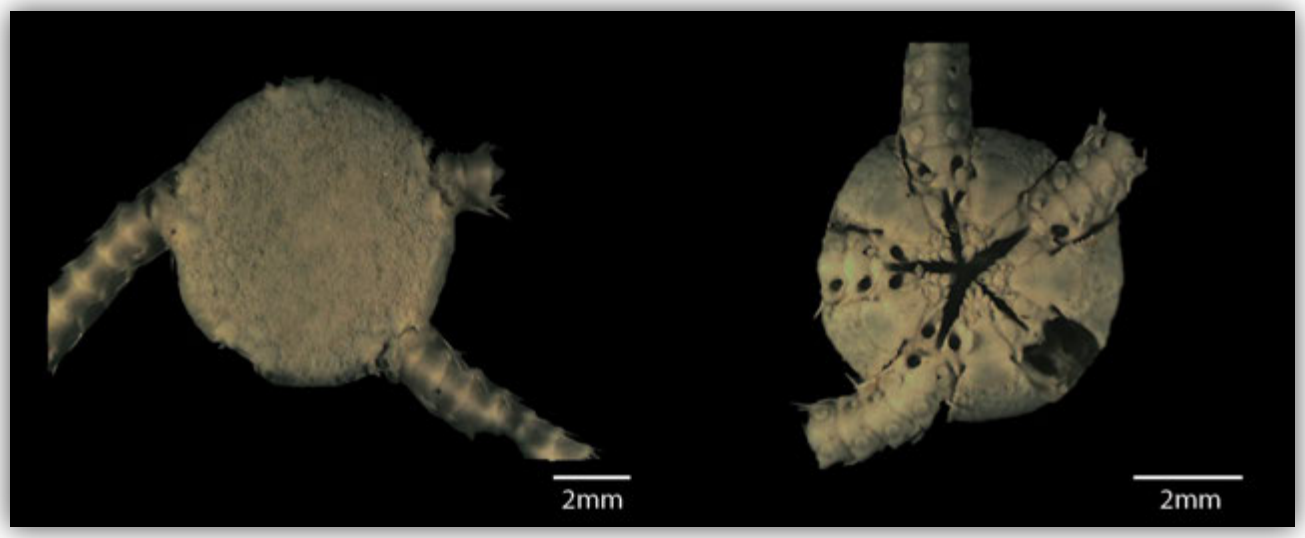

Figure 6.47. Dorsal (left) and ventral (right) views of *Ophiopallas paradoxa* (SAMC A22801).

Genus Amphiophiura **Matsumoto, 1915**

Diagnosis *- adapted from Matsumoto (1915) and Mortensen (1927).*
Disc thickly scaled and plated, primary rosette distinct. Radial shields stout. Oral shields oval, pyriform or trefoil. Arms moderately long, tapering gradually to blunt tips, distinctly keeled. Dorsal and ventral arm plates fairly well-developed, broadly in contact in at least proximal segments, arm spines tapering but blunt, few to numerous. Second oral tentacle pore open or entirely outside oral slits, tentacle pores large. Tentacle scales numerous.

Amphiophiura sculptilis **(Lyman, 1878)**

Figs 6.48 and 6.49.

Ophioglypha sculptilis Lyman, 1878: 84-85, pl. 4, figs 115, 116; Lyman, 1882: 37; Koehler, 1914a: 24.
Ophioglypha variabilis Lyman, 1878: 85-86, pl. 4, figs 113, 114; Lyman, 1882: 37.
Ophiura sculptilis: Ludwig, 1901: 925; Clark, 1911: 77.
Ophioglypha remota Koehler, 1904a: 54, pl. 9, figs 1-3.

Amphiophiura sculptilis Koehler, 1922b: 364; Clark, 1915a: 313; Matsumoto, 1915: 77; Hertz, 1927a: 74; Clark, H.L., 1939: 108; Madsen, 1951: 114; Litvinova, 1971: 299, pl. 3, figs 2, 4, 5; Vadon and Guille, 1984: 588, 592-593, pl. 5, 1-4; Guille and Vadon, 1986: 169; Manso, 2010: 196; Olbers *et al.*, 2015: 91.

Diagnosis *- adapted from Lyman (1878), Vadon and Guille (1984) and Olbers et al. (2015)*.
D.D. up to 15mm. Dorsal disc thick, scales flat, large round central plate, five distinct plates separated by small irregular scales. Radial shields distinct, D-shaped or broad triangular, contiguous distally, tapering proximally with wedge of scales between them, large scale present marginally on dorsal interradial area. Ventral interradial areas scaled, but dominated by large oral shield. Oral shield pentagonal, distal edge rounded, slightly longer than wide, covering most of the ventral disc surface. Adoral shields relatively broad, contiguous. Oral papillae five, broad, closely set, apical papillae blunt. Genital slits moderately long, genital papillae present, squarish becoming spiniform, forming arm combs dorsally. Dorsal arm plates fan or diamond-shaped, rounded distal edge, contiguous. Lateral arm plates broad, meeting ventrally. Ventral arm plates squat, bell-shaped, constricted by large tentacle pores, distal edge longer than proximal edge, wider than long, distal edge straight, becoming rounded, not contiguous. Arm spines up to six, blunt. Tentacle pores large, tentacle scales up to five within disc, two on remaining arm.

Distribution and habitat
Antarctic Ocean, Reunion, Zanzibar, Oman, Bay of Bengal, Indonesia, Japan, South America, Brazil (Koehler, 1914a; Koehler, 1922b; Vadon and Guille, 1984), South Africa: off Durban (KZN) (Guille and Vadon, 1986); depth range: 300-4320m.
Habitat: Grey sand and mud, *Globigerina* ooze.

Remarks
Reported as a new record for South Africa in Olbers *et al.* (2015) from a single record, collected during the French expedition Safari I with the research vessel *Marion-Dufresne.* The syntypes are in the Museum of Comparative Zoology (MCZ OPH-731 and MCZ OPH-715), type locality off Yokohama, Japan, depth 3429m.

Figure 6.48. Distribution of *Amphiophiura sculptilis* in South Africa.

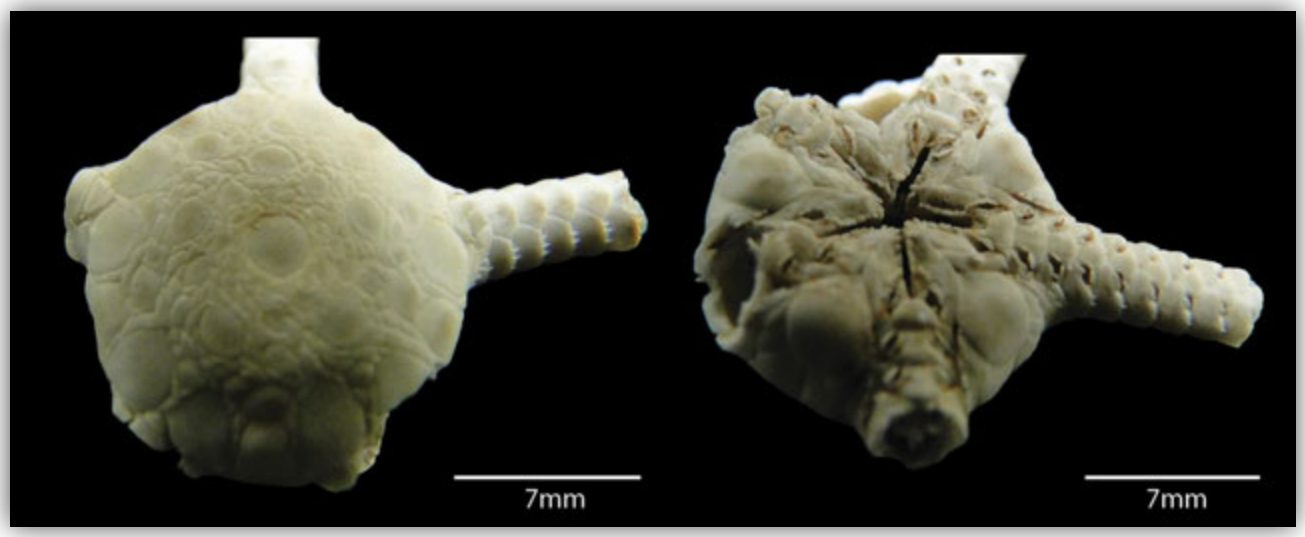

Figure 6.49. Dorsal (left) and ventral (right) views of *Amphiophiura sculptilis* (USNM E42847).

Amphiophiura trifolium Hertz, 1927

Figs 6.50 and 6.51.

Amphiophiura trifolium Hertz, 1927a: 78-79, pl. 6, figs 14, 15; Clark, H.L., 1939: 108-109; Clark, 1974: 476; Clark and Courtman-Stock, 1976: 187, 107, 125.

Diagnosis *- adapted from Hertz (1927a) and Clark and Courtman-Stock (1976).*
D.D. = 6-12mm. Dorsal disc fairly thick, plates thick, moderately distinct, primary and central plates better defined. Radial shields usually distinct, rounded triangular, contiguous distally, length less than half disc radius. Arm combs present, primary set coarse papillae becoming broader ventrally, secondary set with blunt, finer papillae. Ventral interradial areas minimal, scaled, but dominated by the large oral shields, which are trefoil in shape with distalmost side being rounded, broad and proximal side protruding from constriction at about one-third of length. Adoral shields narrow, contiguous proximally. Oral plates slightly sunken. Single apical papillae with 5-6 oral papillae either side, not well defined, some broad. Teeth 2-3, tapering. Dorsal arm plates oval or bell-shaped, twice as long as wide proximally, first 4-5 contiguous, then separated. Lateral arm plates broad and large. Ventral arm plates squat bell-shaped, wider and round on distal side, not contiguous. Arm spines 2-3, small, short, no more than one-third segment length, on the distal arm one spine (usually uppermost) becoming hooked. Genital slits long, genital papillae present only on distalmost side, forming arm combs on dorsal side. Tentacle pores large, tentacle scales 2-3.

Distribution and habitat
Mozambique, Zanzibar, Kenya, Somalia, Maldives (Stöhr, 2007b), South Africa: Margate (KZN) to off Kosi Bay (KZN); depth range: 850-2727m.
Habitat: Hard sand, rock and *Globigerina* ooze.

Remarks
Specimens examined were all damaged and missing arms. The number of tentacle scales could therefore not be determined.

Type material is in the Museum of Natural History at the University of Berlin (syntype: ZMB Ech 6983), type locality off Somalia, depth 1289-1633m.

Figure 6.50. Distribution of *Amphiophiura trifolium* in South Africa.

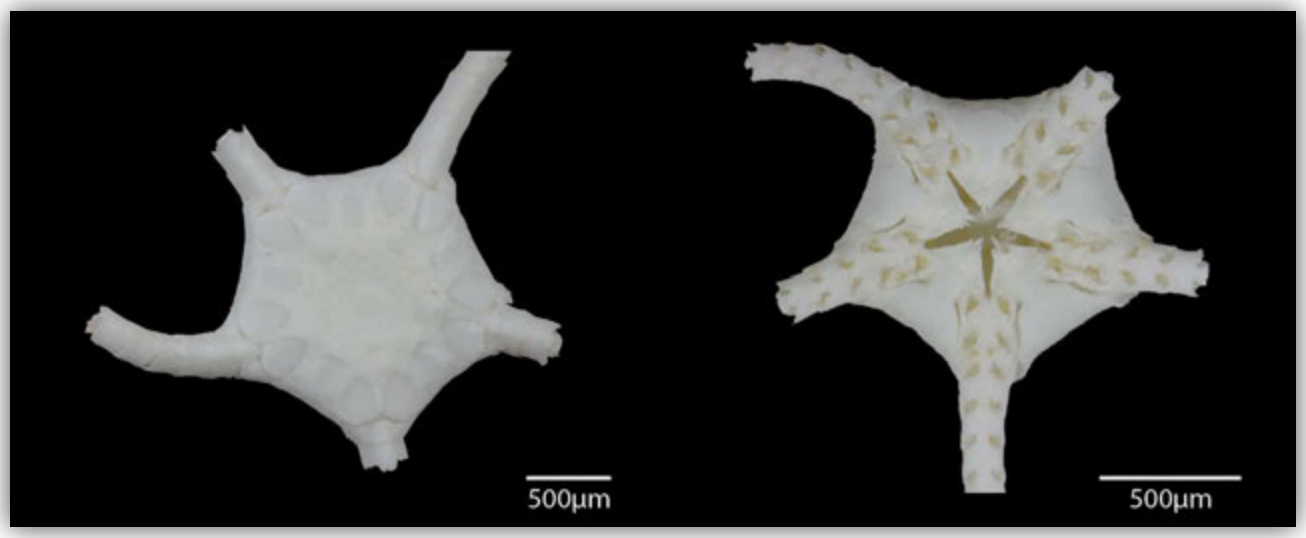

Figure 6.51. Dorsal (left) and ventral (right) views of *Amphiophiura trifolium* (SAMC A23217).

Genus Astrophiura Sladen, 1879

Diagnosis *- adapted from Sladen (1879) and Matsumoto (1917).*
Dorsal disc covered with scales, while modified lateral arm plates appear to form remainder of disc or umbrella, fringed with modified spines along whole disc margin. Radial shields half true disc radius. Oral papillae up to seven. Teeth and dental papillae absent. Dorsal and ventral arm plates rudimentary external to umbrella, but well-developed within. Arms short. Tentacle scales only present within umbrella, tentacle pores very large within umbrella.

Astrophiura permira Sladen, 1878

Figs 6.52 and 6.53.

Astrophiura permira Sladen, 1878: 456-457; Sladen 1879: 401-415, pl. 20; Hertz, 1927a: 83-85, pl. 7, figs 4, 5; Mortensen, 1933c: 394-396, figs 90, 91; Clark and Courtman-Stock, 1976: 125, 107, 188, fig. 207; Clark, 1977: 143-144.
Astrophiura cavellae Koehler, 1915:1-15, figs 1-6; Clark, 1923: 354-356.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. = 2-10mm, disc pentagonal, concave below, central plate with protrusion, disc scales distinct. Disc expanded from modified arm segments, creating an umbrella effect on disc. Single triangular interradial segment with five segments either side, longer than wide, with undulating distal edges meeting arms at right angles. Spines modified to form fringe on expanded disc margin. Undulating edges and modified spines make disc appear to have a double fringe. Oral shields not always distinct, small, triangular. Adoral shields large, more distinct than oral shields, contiguous. Oral papillae four, apical papillae two on apex. Dorsal arm plates not contiguous, triangular, convex distally, distal plates very far apart, separated by large lateral arm plates. First ventral arm plate bell-shaped, other non-free plates square, slightly longer than wide, all plates constricted by large tentacle pores, plates becoming reduced distally by large lateral arm plates. Arm spines short, blunt. No genital slits, genital organs present, sometimes visible through ventral disc. Tentacle scales two, round.

Distribution and habitat
Indo-West Pacific, Madagascar (Sladen, 1878), Australia (Rowe and Gates, 1995), South Africa: Cape Town (WC) to Black Rock (KZN); depth range: 164-1300m.
Habitat: Sand, stones, rock and coral (Clark and Courtman-Stock, 1976).

Remarks
Sladen (1878) briefly described the characters of this species, completing his description in a separate publication in 1879, in which he argues that this species forms a link between the Ophiuroidea and Asteroidea.

Type material is in the Museum of Natural History at the University of Berlin (syntype of *Astrophiura cavellae*: ZMB Ech 7079), type locality being Madagascar.

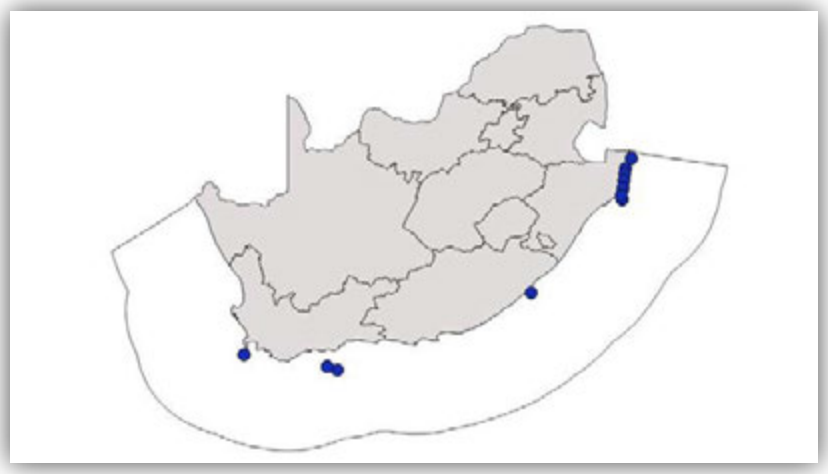

Figure 6.52. Distribution of *Astrophiura permira* in South Africa.

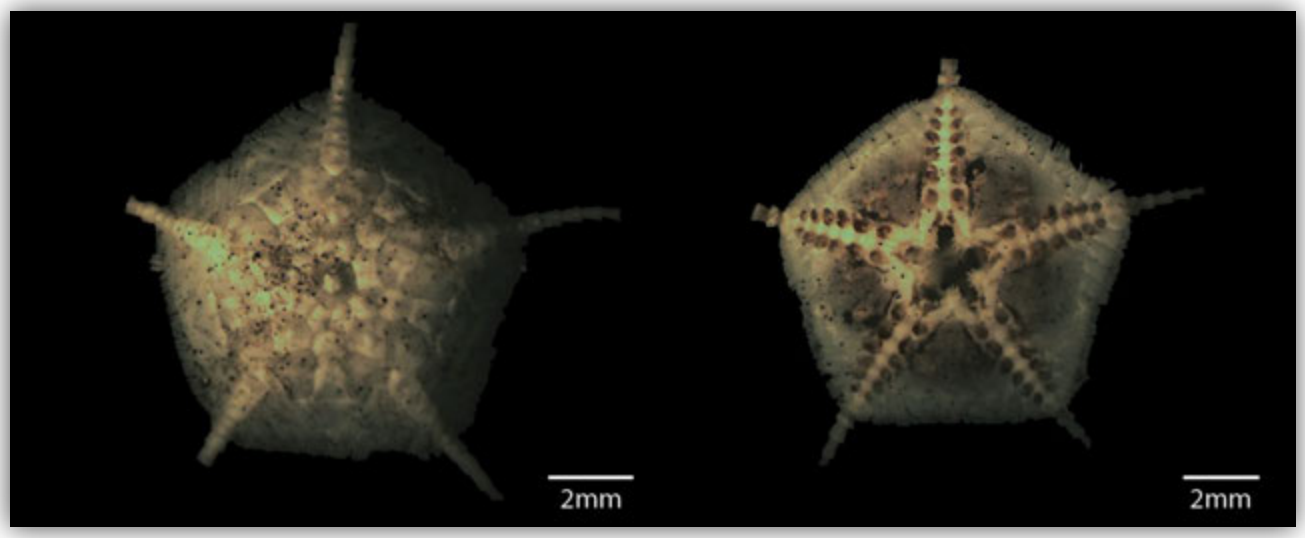

Figure 6.53. Dorsal (left) and ventral (right) views of *Astrophiura permira* (SAMC A6460)

Genus Ophiocten Lütken, 1855

Diagnosis *- adapted from Lütken (1855) and Lyman (1882).*
Disc round, with radial indentations, disc covered in scales and distinct primary rosette. Radial shields may or may not be separated by overlapping scales, ventral interradial areas covered in overlapping scales. Papillae on genital slits may form arm combs over base of arm. Oral papillae and teeth present. Lateral arm plates meeting ventrally, but not dorsally. Tentacle scales present, usually each oral tentacle pore with more than one papilla.

Ophiocten affinis simulans (Mortensen, 1936)
Figs 6.54 and 6.55.

Ophiocten amitinum var. *simulans* Mortensen, 1936: 337, fig. 48b; Day *et al.*, 1970: 81.
Ophiocten amitinum var. *microplax* Mortensen, 1933c: 391-393, fig. 88b.
Ophiura (*Ophiura*) *affinis simulans*: Clark and Courtman-Stock, 1976: 192-193, 125, 107.
Ophiura affinis simulans: Guille, 1982: 79, fig. 7e, f.

Diagnosis *- adapted from Mortensen (1936) and Clark and Courtman-Stock (1976).*
D.D. = 2mm. Disc flattened, large symmetrical circular plates, including rosette, all encircled by smaller scales. Radial shields approximating distally, separated by scales. Edge of disc slightly indented radially, arm combs distinct, some additional papillae also present in indentation. Oral shields longer than wide, sometimes twice as long as wide, distal lobe only slightly tapering to broadly rounded tip, surface textured with folds. Adoral shields contiguous and narrow. Oral papillae three each side of apical papillae, distalmost broad. Oral tentacle pore slightly set back, with one scale either side of pore. Dorsal arm plates carinate, trapezoidal, proximal plates broadly contiguous. Ventral arm plates semi-circular, small, not contiguous, separated by lateral arm plates. Arm spines three, slender and pointed, uppermost two spines only slightly exceeding segment length, if at all, not thicker than adjacent spine. Tentacle scales two on first two pairs of tentacle pores, then one, broad and rounded, not longer than wide, tentacle pores and scales distinct for most of arm.

Distribution and habitat
South Africa: Lambert's Bay (WC) to Port Elizabeth (EC); depth range: 55-273m.
Habitat: Coarse to fine sand, shell and rock.

Remarks

Endemic to South Africa (see Table 7.4). Clark and Courtman-Stock (1976) suggested that the differences between South African *Ophiura* and *Ophiocten* species are very slight. They placed *affinis simulans* in *Ophiura* but for the purposes of this account, it was placed in *Ophiocten* as per the nomenclature of Stöhr *et al.* (2016).

The type material is in the Museum of Comparative Zoology (paratype: MCZ OPH-5912), type locality Port Elizabeth, South Africa. Syntypes (*Ophiocten amitinum* var. *microplax*) are in the Natural History Museum of Denmark (ZMUC OPH-200) with the type locality as Roman Rock, False Bay, depth 35m. The two specimens accessioned in the Iziko South African Museum were registered as 'cotypes' (examined).

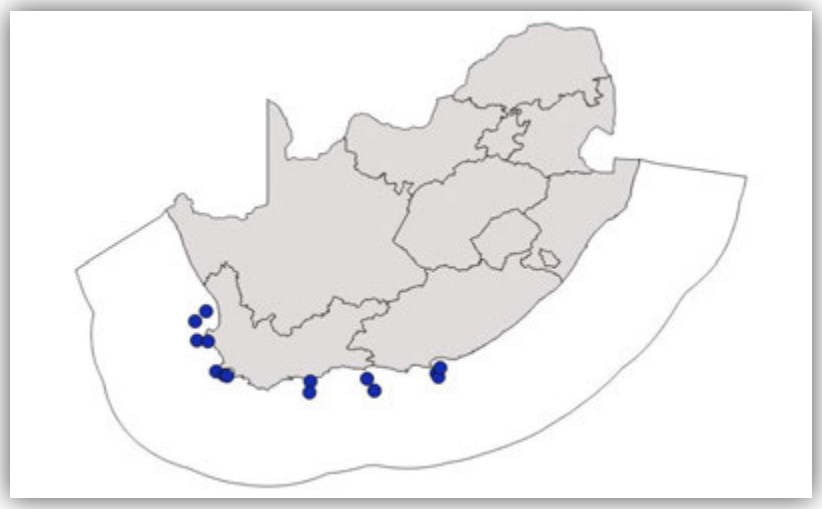

Figure 6.54. Distribution of *Ophiocten affinis simulans* in South Africa.

Figure 6.55. Dorsal (left) and ventral (right) views of *Ophiocten affinis simulans* (SAMC A088402).

Ophiocten amitinum Lyman, 1878

Figs 6.56 and 6.57.

Ophiocten amitinum Lyman, 1878: 100-101, pl. 5, figs 129-130. Lyman, 1882: 79-80, pl. 9, figs 7-9; Studer, 1882: 16, pl. 2, fig. 8a-f; Murray, 1896: 359, 369, 416, 436; Ludwig, 1899, 4; Koehler, 1907: 288; Clark, 1915a: 328; Clark, 1923: 363-364, Mortensen, 1933c: 390-391, fig. 88a; Madsen, 1967: 138; Clark and Courtman-Stock, 1976: 192; Dahm, 1999: 429; Gutt *et al.*, 1999: 160; De Castro Manso, 2010: 192-193, fig. 8a.
Ophiura amitina: Guille, 1982: 78-79, figs 6a-c, 7c, d.

Diagnosis *- adapted from Lyman (1878) and Clark and Courtman-Stock (1976).*
D.D. = 2-10mm. Disc round, flattened, primary rosette scales encircled by smaller overlapping scales. Radial shields approximating on distal side, narrowly separated by scales. Edge of disc indented, arm combs distinct, with some additional papillae also present in indentation. Ventral interradial areas with overlapping scales. Oral shields longer than wide, distal lobe tapering to rounded tip (trefoil-shaped). Adoral shields contiguous and narrow. Oral papillae 3-4 each side of apical papillae, elliptical leaf-shaped, distalmost broadest. Teeth 3-4, similar in shape to apical papillae. First oral tentacle pore large, with 2-4 tentacles scales. Genital slits elongated, papillae present. Dorsal arm plates wider than long proximally and equally wide as long distally, broadly contiguous. Ventral arm plates semi-circular, not contiguous, separated by large lateral arm plates. Arm spines three, slender and pointed, uppermost spine only slightly exceeding segment length, if at all, not thicker than adjacent spine. Tentacle scales one, broad and rounded with a slight tip.

Distribution and habitat
Patagonia, Southern Ocean (Lyman, 1878; Murray, 1896; Clark, 1915a), South Africa: Lambert's Bay (WC) to East London (EC); depth range: 110-3566m.
Habitat: Sand, mud, stones or gravel.

Remarks
The specimens collected at stations FAL185P and TRA74L (University of Cape Town Ecological Survey) were originally identified as *O. affinis simulans* (unknown determinant) but were changed to *O. amitinum* in 1973 by A.M. Clark. Clark and Courtman-Stock (1976) recorded only slight differences between *O. amitinum* and *O. affinis simulans,* such as the radial shields, arm comb papillae, cross section of the arms, uppermost arm spine and tentacle scales. The major differences in all the above characters were not consistent in all the *O. amitinum* specimens examined in the Iziko South African Museum collection. The easiest character to differentiate between species is the tentacle scale arrangement. Clark and Courtman-Stock (1976) recorded that the tentacle scales in *O. amitinum* were longer than wide and tapered to a point, while those in *O. affinis simulans* were evenly rounded. This was observed in all the *O. amitinum* specimens examined. The number of tentacle scales on the first tentacle pore was also inconsistent.

The relationship between *Ophiura* and *Ophiocten* has been debated by various authors (Mortensen, 1927; Mortensen, 1936, Clark and Courtman-Stock, 1976; Paterson *et al.*, 1982 and Martynov, 2010). In 1936, Mortensen erected *Ophiocten amitinum* var. *simulans* for the South African variety of *Ophiura affinis*. Later, *Ophiura affinis* Lütken, 1855 was placed into the genus *Ophiocten* Lütken, 1855 by Sumida *et al.* (1998). A distribution record for South Africa of *Ophiura affinis* exists in the Natural History Museum of Denmark, but it is unlikely this was identified correctly and it is most probably *Ophiocten affinis simulans* (Mortensen, 1936). Until examination of this specimen takes place, this distribution record is not recognised in this account. Further investigation of the validity of the South African *O. amitinum* and *O. affinis simulans* specimens is recommended.

The type material is in the Museum of Comparative Zoology (syntype: MCZ OPH-761), type locality Kerguelen Islands, depth unknown.

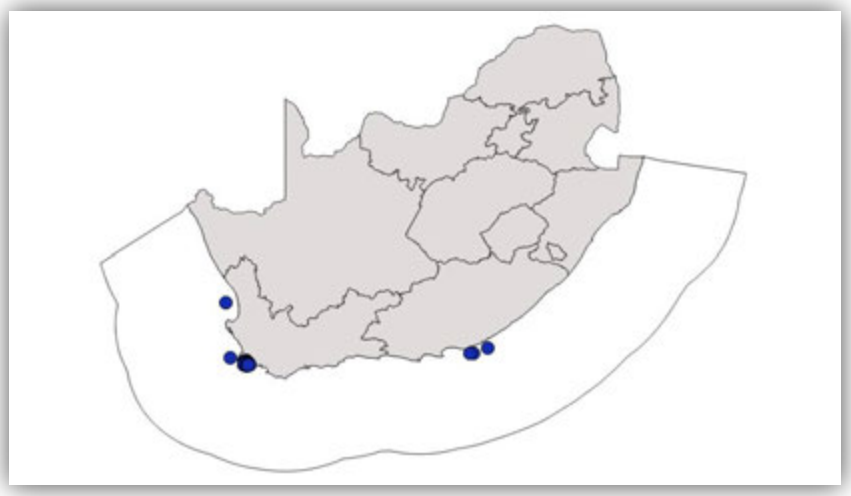

Figure 6.56. Distribution of *Ophiocten amitinum* in South Africa.

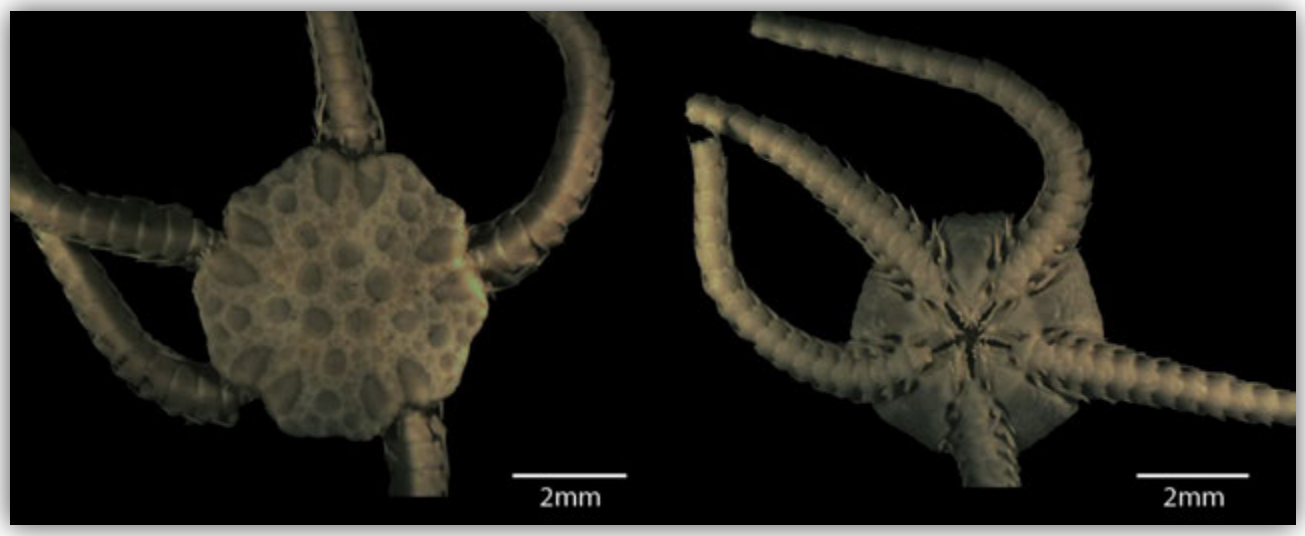

Figure 6.57. Dorsal (left) and ventral (right) views of *Ophiocten amitinum* (SAMC A084234).

***Ophiocten hastatum* Lyman, 1878**

Figs 6.58 and 6.59.

Ophiocten hastatum Lyman, 1878: 103, pl. 5, figs 133-134; Lyman, 1882: 82-83, pl. 9, figs 10-11.
Ophiocten longispinum Koehler, 1896a: 204-205b; Koehler, 1896b: 243.
Ophiocten pacificum Lütken and Mortensen, 1899: 131-132, pl. 3, figs 5-7; Clark, 1923: 364.
Ophiocten latens Koehler, 1906: 13, pl. 1, figs 9, 10; Mortensen, 1927: 246; Mortensen, 1933c: 392-393; Clark and Courtman-Stock, 1976: 189, 107, 125, figs 215, 219.
Ophiocten australis Baker, 1979: 26-28, fig. 3a-c.
Ophiura hastata: Guille, 1982: 80, figs 6d, e, 7a, b.

Diagnosis *- adapted from Lyman (1878) and Clark and Courtman-Stock (1976).*
D.D. = 4-14mm. Disc round, flat dorsally and rounded ventrally. Disc scales medium in size, primary rosette present, not distinct in all specimens, interspersed with smaller overlapping scales. Radial shields triangular in shape with rounded angles, length less than half disc radius, not contiguous,

separated by fine overlapping scales. Arm combs or papillae may be present, but easily lost. Ventral interradial areas covered in fine overlapping scales. Oral shields large, as long as wide but usually much wider, five-sided, distal edge rounded, proximal edge pointed. Adoral shields narrow and contiguous. Oral papillae 3-5 either side of pointed apical papillae, square. Teeth four, similar in shape to apical papillae. Genital slits long, reaching to almost dorsal side. Arms carinate dorsally, dorsal arm plates flat pentagonal, wider than long, distally equally long as wide, broadly contiguous. Ventral arm plates semi-circular, not contiguous, separated by large lateral arm plates. Arm spines three, uppermost much longer than segment and adjacent spines, sometimes thicker than other spines, remaining spines thin, pointed and about one segment length. Oral tentacle pore adjacent to adoral shield with 4-5 rounded scales, remaining pores with single tiny tentacle scale.

Distribution and habitat

Atlantic Ocean, Bay of Biscay, Spain, southern Australia, New Zealand, Kerguelen Islands, Pacific Ocean (Mortensen, 1927; Clark and Courtman-Stock, 1976), South Africa: Saldanha Bay (WC) to Gansbaai (WC); depth range: 910-4060m.
Habitat: *Globigerina* ooze (Lyman, 1882); green and grey mud.

Remarks

Specimens examined were missing their arm combs, but Clark and Courtman-Stock (1976) (as *O. latens*) noted that these were easily lost.

The type material is in the Museum of Comparative Zoology (syntypes: MCZ OPH-1019, MCZ OPH-765, MCZ OPH-767), type locality is west of Marion Island, depth 2514m.

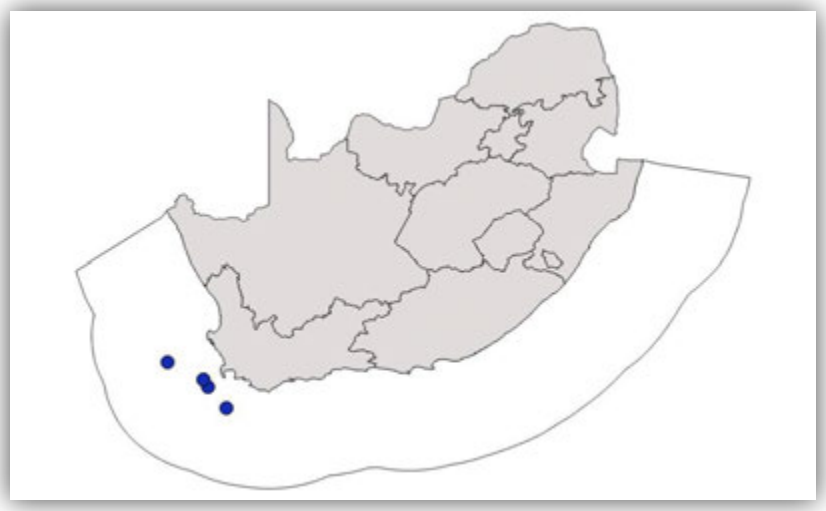

Figure 6.58. Distribution of *Ophiocten hastatum* in South Africa.

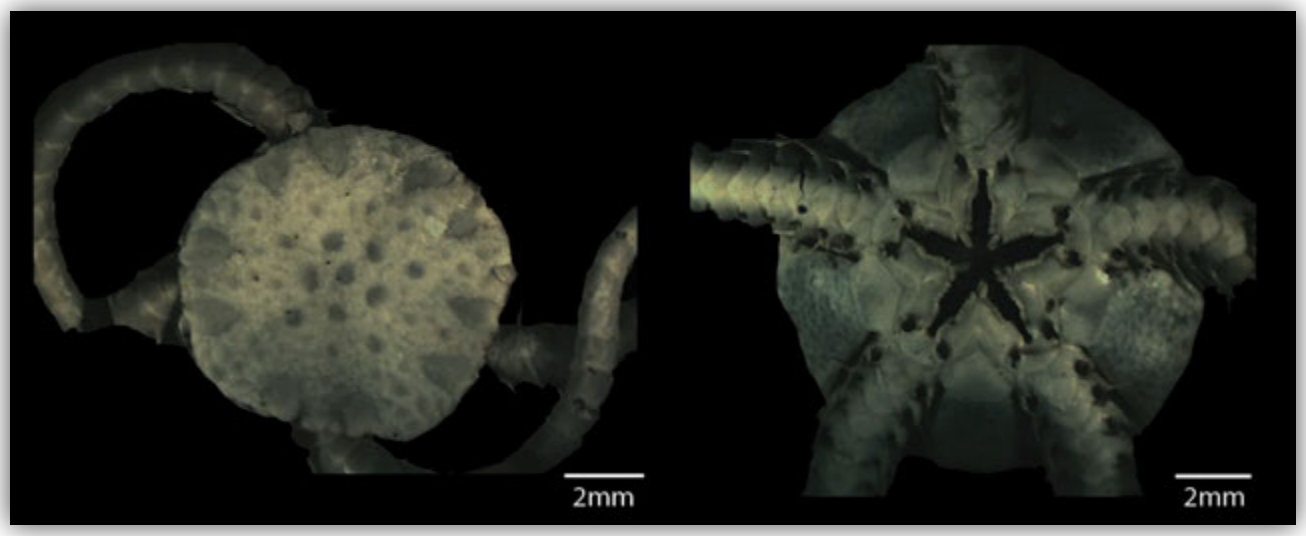

Figure 6.59. Dorsal (left) and ventral (right) views of *Ophiocten hastatum* (SAMC A7475).

Genus Ophiomisidium Koehler, 1914

Diagnosis - *adapted from Wyville Thomson (1878) and Borges and de Siqueira Campos (2011).*
Adults small, D.D. up to 5mm, disc covered dorsally with medium-sized plates in addition to a primary rosette. Number of tentacle pores vary, but usually more than two. Dorsal and ventral proximal arm plates wider than distal plates, first three ventral arm plates well-developed. Ventral interradial areas reduced or absent. Genital slits reduced or absent.

Ophiomisidium pulchellum (Wyville Thomson, 1878)

Figs 6.60 and 6.61.

Ophiomusium pulchellum Wyville Thomson, 1878: 65-67, figs 18, 19; Lyman, 1882: 96-98, pl. 3, figs 1-3.
Ophiomisidium pulchellum Koehler, 1914a: 37; Clark, 1915a: 308; Clark and Courtman-Stock, 1976: 190-191, 125, 107, fig. 211; Clark, 1923: 356-357; Hertz, 1927a: 82; Clark, 1974: 476; Paterson, 1985: 141, fig. 53; Borges and de Siqueira Campos, 2011: 222-224, figs 6-10; Hernández-Herrejón *et al.*, 2008: 102-104, fig. 4a, b; Laguarda-Figueras *et al.*, 2009: 84, fig. 24.

Diagnosis - *adapted from Lyman (1882) and Clark and Courtman-Stock (1976).*
D.D. = 3-5mm, D.D./A.L. = *c.*1/1-2, disc round, slightly inflated. Primary rosette distinct, plates large, thick, taking up most of dorsal disc. Radial shields oval, not contiguous distally, separated by two plates or scales, distalmost plate triangular. Two plates in dorsal interradial areas, distal plate on disc margin with small, semi-circular, knob-like tubercle extending beyond disc margin. Ventral interradial area covered in elongated trapezoid plate, from edge of oral shield to disc margin. Oral shields diamond-shaped with rounded distal edge, equally long as wide. Adoral shields larger, contiguous. Oral papillae two, fused each side of triangular apical papillae. Genital slits with very small opening between genital plate and first lateral arm plate. Genital plates may touch each other near oral shield. Arms short, only consisting of *c.*15 segments. First dorsal arm plates twice as wide as long, with proximal side touching a triangular plate which separates radial shields, distal margin of remaining dorsal arm plates rounded, plates decreasing in size distally. First four ventral arm plates bell-shaped, not contiguous, decreasing in size distally, becoming triangular. Lateral arm plates well-developed, joined both dorsally and ventrally. First lateral arm plate with 2-4 enlarged, flattened arm spines,

remaining arm segments with three short, blunt spines, rapidly decreasing in size down arm. Five pairs of tentacle pores with a single, large tentacle scale, being lost abruptly after first 2-5 segments.

Distribution and habitat

Canary Islands, Atlantic Ocean (Lyman, 1882; Clark and Courtman-Stock, 1976; Borges and de Siqueira Campos, 2011), South Africa: Cape Town (WC) to Amanzimtoti (KZN); depth range: 70-3065m.

Habitat: Sand and stones.

Remarks

The distribution range within South Africa here extended to KZN (see Table 7.3). The diagnostic features between *Ophiomusium* Lyman, 1869 (Ophiolepididae) and *Ophiomisidium* Koehler, 1914a (Ophiuridae) are very similar. In *Ophiomisidium*, the tentacle pore associated with the first ventral arm plate is outside the oral slit, while in *Ophiomusium*, it is inside the oral slit and is seldom seen. In addition, in *Ophiomusium*, there are only two (or less) pairs of tentacle pores. In the past, *Ophiomisidium pulchellum* (Wyville Thomson, 1878) was included in *Ophiomusium* until Koehler (1914a) created the genus *Ophiomisidium*.

Type whereabouts are unknown. Type locality south-west of the Canary Islands, depth 3063m (Clark and Courtman-Stock, 1976).

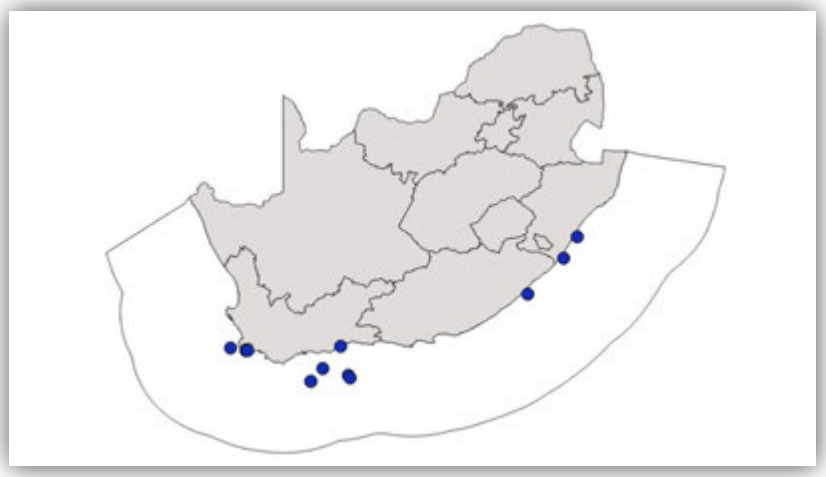

Figure 6.60. Distribution of *Ophiomisidium pulchellum* in South Africa.

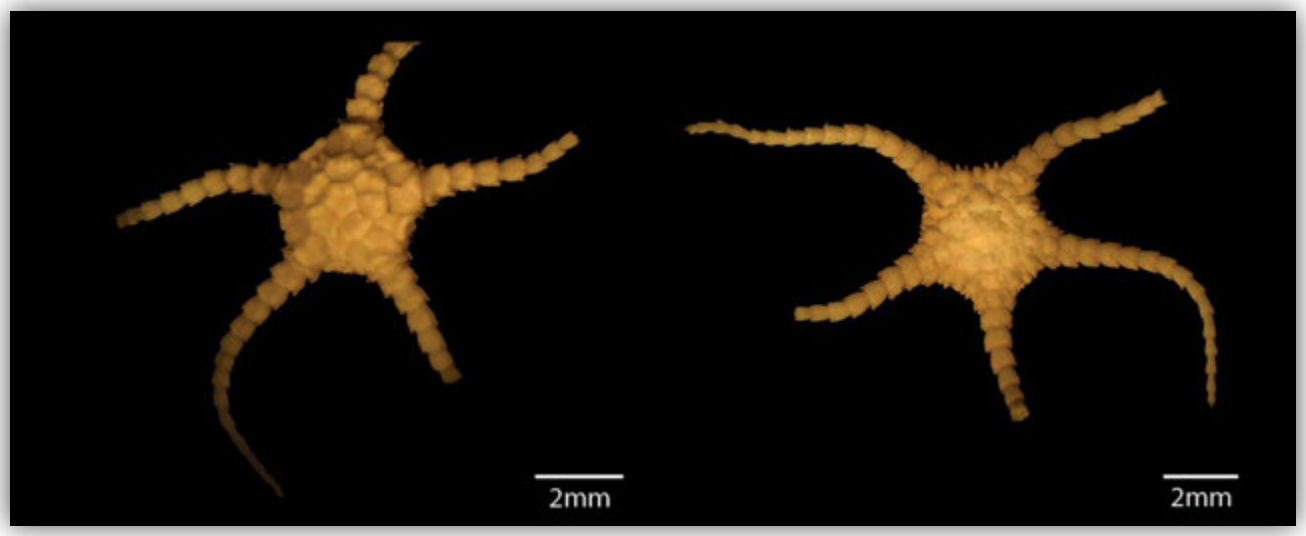

Figure 6.61. Dorsal (left) and ventral (right) views of *Ophiomisidium pulchellum* (SAMC A084246).

Genus Ophiura Lamarck, 1801

Diagnosis *- adapted from Matsumoto (1917) and Clark and Courtman-Stock (1976).*
Disc flat, covered with scales, usually small, sometimes armed with scattered spines, primary rosette usually distinct. Radial shields mostly not contiguous. Genital papillae well-developed, arm combs usually present. Second oral tentacle pore usually outside the oral slits, sometimes opening into oral slit on adradial side with numerous scales and may form a continuous series with oral papillae. Arms flat or cylindrical, tapering, not stout. Dorsal arm plates usually well-developed, usually broadly contiguous. Ventral arm plates small, usually separated from one another by large lateral arm plates bearing 3-7 arm spines, tapering but blunt or needle-like, appressed or flaring. Proximal tentacle pores large, with numerous scales. Tentacle scales one, two or many, becoming very small distally.

Ophiura flagellata (Lyman, 1878)

Figs 6.62 and 6.63.

Ophioglypha flagellata Lyman, 1878: 69, pl. 2, figs 49-51; Lyman, 1882: 42, pl. 4, figs 16-18; Koehler, 1899: 18-19; Koehler, 1904a: 56; Koehler, 1907: 294.
Gymnophiura coerulescens Lütken and Mortensen, 1899: 114-116: pl. 7, figs 4-6.
Ophiura flagellata: Clark, 1911: 60-62, fig. 15; Matsumoto, 1917: 273-274; Koehler, 1922b: 375-377, pl. 85, figs 1, 6, 7, pl. 86, figs 1-4, 10; Clark, 1923: 359-360; Mortensen, 1933c: 383-384; Murakami, 1942: 28; Baker, 1979, 22, fig. 1a, c, e; Imaoka *et al.*, 1990: 97, fig. 55.
Ophiura (*Ophiura*) *flagellata*: Clark and Courtman-Stock, 1976: 193-194, figs 221, 127, 107; Alva and Vadon, 1989: 828-829, 841.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. = 9-29mm, disc pentagonal. Central disc plate covered in skin, not distinct in adults, surrounded by overlapping medium-sized scales. Radial shields small, oval in shape, partly covered by disc scales, widely separated. Arm combs present at base of arms. Ventral interradial area covered in overlapping scales, but most of area taken up by large pentagonal oral shield with pointed proximal edge, equally long as wide, elongated in larger specimens. Adoral shields contiguous. Oral papillae five either side of rounded apical papillae, all squarish slightly tapering, distalmost smaller but not broader. Oral papillae in series with oral tentacle scales. Genital slits long, single and armed with many sharp genital papillae. First dorsal arm plates triangular, wider than long, with convex distal edge, remaining plates hexagonal, wider than long, contiguous for length of arm. Ventral arm plates rhombic proximally, wider than long, becoming diamond-shaped, but still wider than long, contiguous until fourth or fifth segment then separated by lateral arm plates, ventral arm plates becoming reduced distally. Oral tentacle pores within oral slit, with up to ten oral tentacle scales. Arm spines three, uppermost longest, about one to one-and-a-half times segment length, tapering but not sharp. Tentacle scales, many (up to eight in examined specimens) in proximal parts of arm, reducing to one distally.

Distribution and habitat
Bering Sea, Andaman Islands, Indonesia, Japan, Australia, Tasman Sea, western Mexico, eastern Atlantic (Baker, 1979; Rowe and Gates, 1995), South Africa: off Saldanha Bay (WC) to North of Richards Bay (KZN); depth range: 96-2330m (Baker, 1979).
Habitat: Mud.

Remarks
Syntypes in the Natural History Museum in London (NHMUK 1882.12.23.444), type locality Japan (Rowe and Gates, 1995), depth unknown.

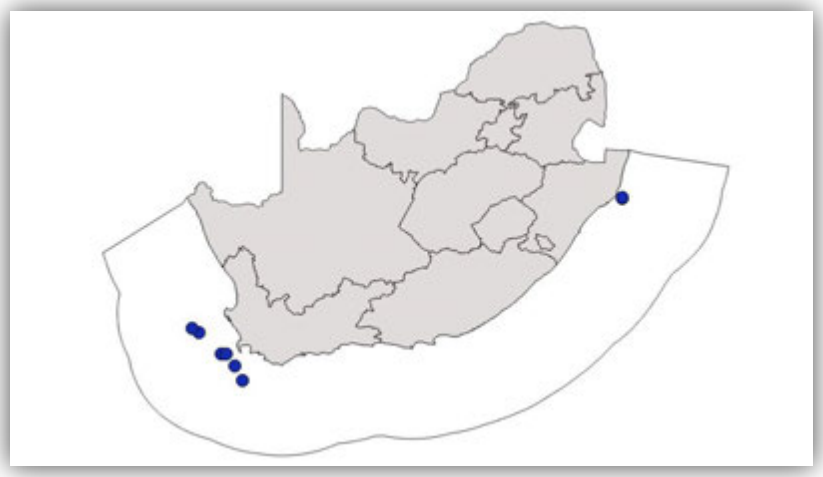

Figure 6.62. Distribution of *Ophiura flagellata* in South Africa.

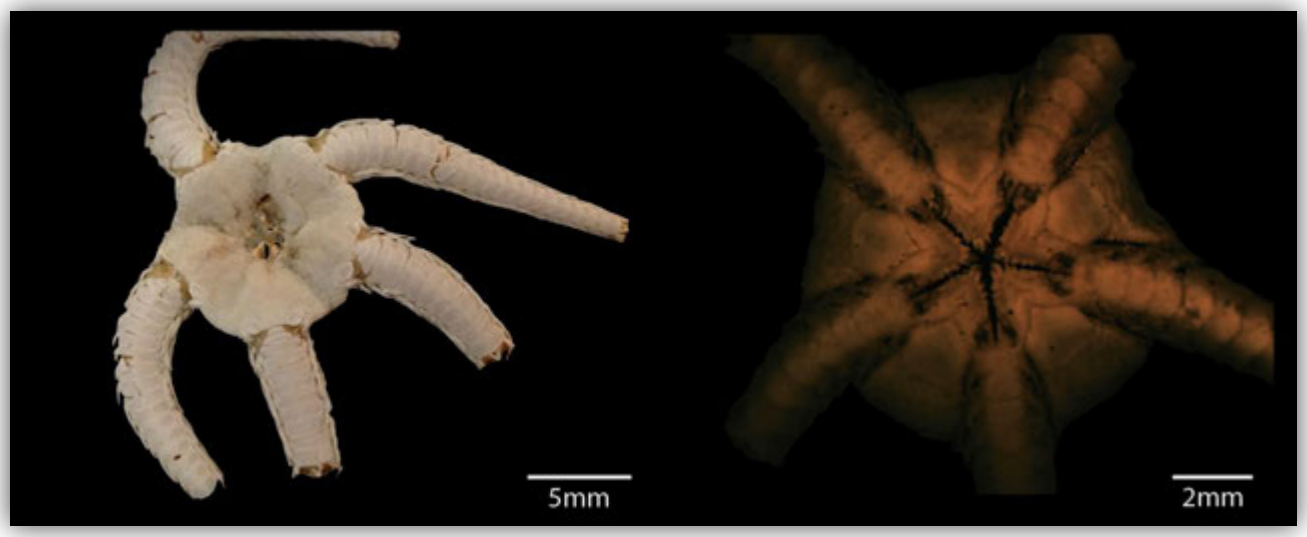

Figure 6.63. Dorsal (left) and ventral (right) views of *Ophiura flagellata* (SAMC A7470).

***Ophiura kinbergi* Ljungman, 1867**

Figs 6.64 and 6.65.

Ophiura kinbergi Ljungman, 1867a: 166; Lyman, 1882: 38-39, pl. 4, fig. 7; Koehler, 1905a: 22-24; Koehler, 1907: 294; Clark, 1911, 37, fig. 9; Matsumoto, 1917: 271-272, fig. 73; Rowe and Gates, 1995: 437-438; Clark and Rowe, 1971: 128, fig. 46b, pl. 22, figs 5, 6. Ludwig, 1901: 925; Price, 1981: 7; Vine, 1986: 195; Imaoka *et al.*, 1991: 96, fig. 54; Liao and Clark, 1995: 303-304, fig. 173.
Ophioglypha kinbergi Ljungman, 1867b: 166.
Ophioglypha sinensis Lyman, 1871: 12-14, pl. 1, figs 1, 2; Lyman, 1878, 99; Döderlein, 1896, 283-284, pl. 15, figs 3, 3a; Koehler, 1898b: 60, pl. 2, fig. 6, pl. 4, fig. 39.
Ophioglypha ferruginea Lyman, 1878: 68, pl. 3, fig. 76.
Ophiura (*Ophiura*) *kinbergi*: Clark and Courtman-Stock, 1976: 194, 127, 107, fig. 222.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. = 8-9.5mm. Disc round, disc scales thick, primary rosette distinct and surrounded by slightly smaller scales. Radial shields oval, tapering slightly on distal side, longer than wide, *c.* one-third to half disc radius, approximating distally but not contiguous, separated by scales. Arm combs present, distinct with long, sharp, tapering papillae. Ventral interradial area covered in overlapping scales. Oral

shields large, pentagonal, constricted in vicinity of genital slits. Adoral shields narrow, contiguous. Oral papillae three, either side of apical papillae, pointed. Teeth five, same shape as apical papillae. Genital slits long, single and armed with small, conical, blunt genital papillae. Dorsal arm plates trapezoid, wider than long proximally, becoming longer than wide, contiguous. Ventral arm plates small, oval, wider than long, pointed on proximal side, separated by large lateral arm plates which meet ventrally and form cavity or hollow on first 3-5 segments. Arm spines three, one segment length, tapering. Oral tentacle pores with *c.* three rounded tentacle scales. Tentacle scales 2-3 on first few segments, then single rounded large scale for length of arm. Colour in life uniformly grey (Rowe and Gates, 1995).

Distribution and habitat

Red Sea, Gulf of Thailand, Andaman Sea, Japan, Australia, Indo-Pacific southwards towards and including Bass Strait, south east Arabia, Persian Gulf, West India, Pakistan, Ceylon, Bay of Bengal, East Indies, Philippines, China, South Pacific Islands and Hawaii (Lyman, 1878; Matsumoto, 1917; Clark and Rowe, 1971; Tortonese, 1977; Rowe and Gates, 1995; Putchakarn and Sonchaeng, 2004), South Africa: Amatikulu (KZN) to Sodwana Bay (KZN); depth range: 0-500m.
Habitat: Sand and sea grass beds.

Remarks

Distribution of this species here extended from Amatikulu to Sodwana Bay (see Table 7.3). The type material is in the Museum of Comparative Zoology (holotype: MCZ OPH-623, paratypes: MCZ OPH-4114, MCZ OPH-975), type locality Hong Kong, depth unknown.

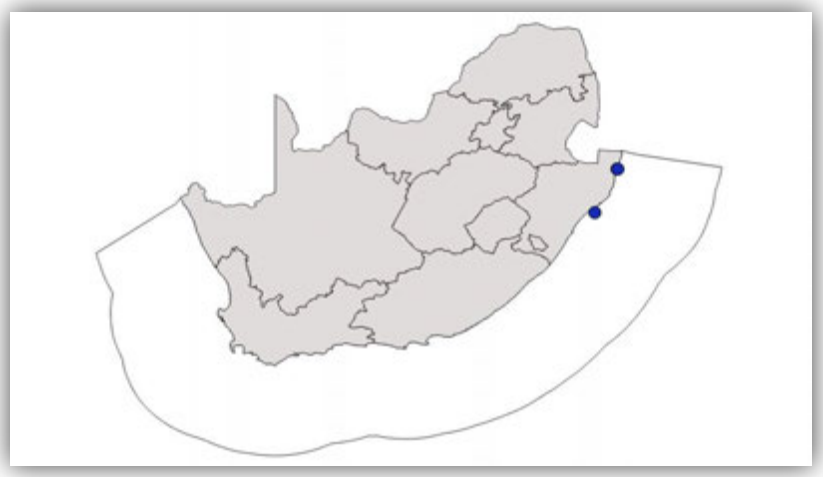

Figure 6.64. Distribution of *Ophiura kinbergi* in South Africa.

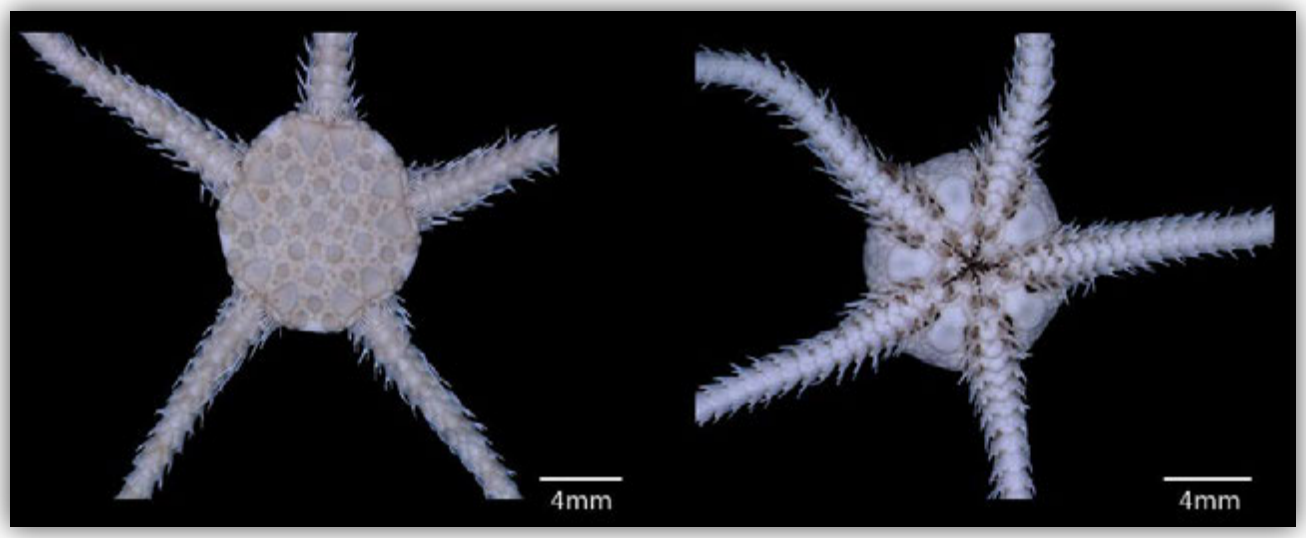

Figure 6.65. Dorsal (left) and ventral (right) views of *Ophiura kinbergi* (RMCA MT1566).

***Ophiura ljungmani* (Lyman, 1878)**

Figs 6.66 and 6.67.

Ophioglypha lepida Lyman, 1878: 70-71, pl. 3, figs 71-73, Lyman, 1882: 43-44, pl. 4, figs 1-3; Koehler, 1907: 294; Koehler, 1914a: 20.
Ophioglypha ljungmani Lyman, 1878: 71-72, pl. 3, fig. 77; Lyman, 1882: 44-45, pl. 4, figs 8-10; Koehler, 1907: 294.
Ophioglypha thouleti Koehler, 1895: 456-458, fig. 4; Koehler, 1896a: 241; Koehler, 1909b: 158-159, pl. 6, fig. 6; pl. 26, figs 1, 2.
Ophiura ljungmani Ludwig, 1901: 925; Clark, 1915a: 321; Mortensen, 1927: 240-242, fig. 130; Clark, 1954: 377; Alva and Vadon, 1989: 828; Hernández-Herrejón *et al.*, 2008: 101-102, fig. 3e-f ; Laguarda-Figueras *et al.*, 2009: 74-75, fig. 19.
Ophiura lepida Ludwig, 1901: 925.
Ophioglypha ljungmanni: Koehler, 1906: 6; Koehler, 1909b: 152.
Ophiura (Ophiura) ljungmani: Paterson, 1985:118-120, fig. 44; Alva and Vadon, 1989: 828-829, 841-831, fig. 8a, b.

Diagnosis *- adapted from Lyman (1882) and Mortensen (1927).*
D.D. = 6-13mm, disc round. Central disc plate and primary rosette distinct in some specimens, remainder of disc covered in scales and small spines (easily rubbed off), scales larger towards disc margin. Radial shields pyriform or teardrop-shaped, half disc radius in length, separated by scales, may or may not be contiguous distally. Arm combs present at arm bases, comb papillae longest in middle of comb. Ventral interradial area covered in overlapping scales, but most of area taken up by large, triangular oral shield. Adoral shields narrow, contiguous. Oral papillae 3-4 either side of blunt apical papillae. Teeth 3-4, uppermost two square, others same shape as apical papillae. Genital slits long, single and armed with many small genital papillae. Dorsal arm plates rhombic, convex distally, contiguous proximally, almost as wide as long, becoming longer than wide and not contiguous on distal arm. Ventral arm plates fan-shaped, distal edge convex, not contiguous, becoming semi-circular, separated by large lateral arm plates. Arm spines three, small, tapering, high on lateral arm plate, upper arm spines as long as segment length, lower spines no longer than half segment length, arm spines begin on second or third segment and similar in size to tentacle scales. Oral tentacle pores with many scales, up to 10 on first and second oral pore. Tentacles scales on remainder of arm vary from 1-3.

Distribution and habitat
Brazil, Mexico, Tobago, Bay of Biscay, Azores, Florida north to Labrador Basin, south east Iceland to North Africa (Clark, 1915a; Mortensen, 1927; Paterson, 1985; Laguarda-Figueras *et al.*, 2009), South Africa: off Orange River (NC) to off Cape Town (WC); depth range: 528-3906m.
Habitat: Mud.

Remarks
Disc spines were only seen on a single examined specimen, many specimens damaged. Paterson (1985) also recorded that disc spines had been rubbed off in many specimens he examined. Radial shields usually not contiguous, this variation also noted by Lyman (1882).

Paterson (1985) stated that *Ophiura (Ophiura) ljungmani* had been recorded in 'Southern Africa' but the source of this record could not be traced. In addition, Paterson (1985) also stated the type specimens of *Ophioglypha lepida* were in the Natural History Museum in London, however, these types could not be traced in the online catalogue. Type locality off Bermuda, depth 2469m.

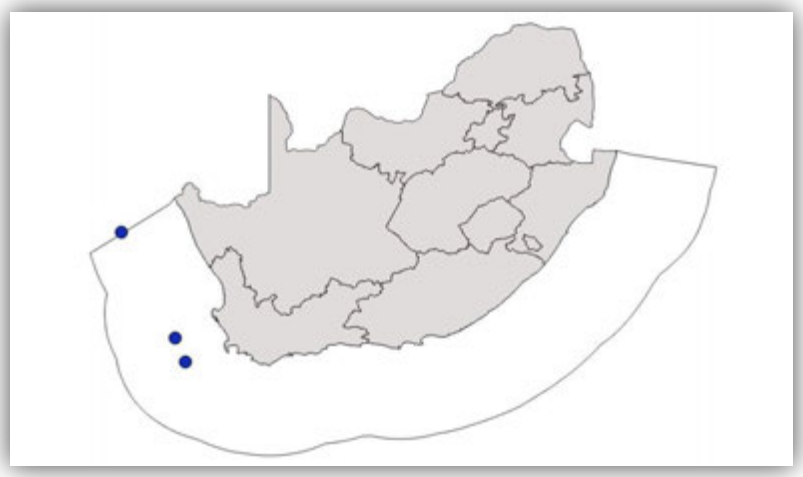

Figure 6.66. Distribution of *Ophiura ljungmani* in South Africa.

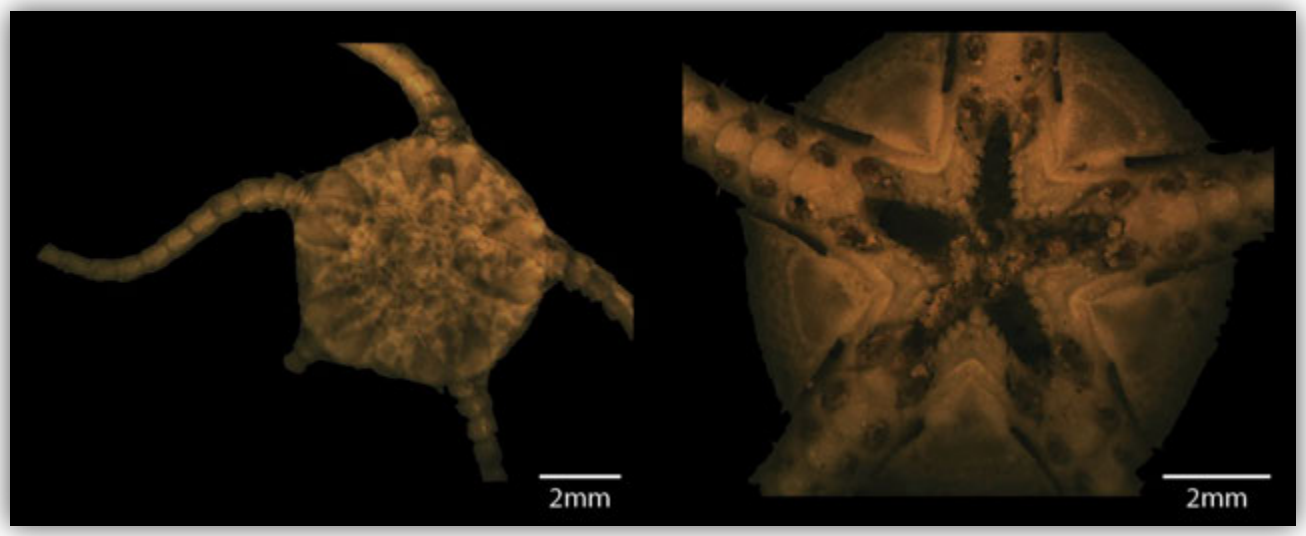

Figure 6.67. Dorsal (left) and ventral (right) views of *Ophiura ljungmani* (SAMC A23344).

Genus Ophiura (Dictenophiura) H.L. Clark, 1923

Diagnosis *- adapted from Clark (1923) and McKnight (2003).*
Primary dorsal disc scales enlarged. Radial shields contiguous. Double arm combs. More disc scales than *Ophiura* (*Ophiura*).

Ophiura (Dictenophiura) anoidea H.L. Clark, 1923

Figs 6.68 and 6.69.

Dictenophiura anoidea Clark, 1923: 361-363, pl. 19, figs 1, 2; Mortensen, 1933c: 388-390, figs 86, 87a; Clark and Courtman-Stock, 1976: 188, 125, 107, fig. 220; Morgans, 1959: 303; Day *et al.*, 1970: 80.

Diagnosis *- adapted from Clark (1923) and Clark and Courtman-Stock (1976).*
D.D. = 3-10mm, disc round, thick with vertical edge, disc scales thick, primary rosette distinct in most specimens, surrounded by slightly smaller scales. Radial shields oval or pyriform, longer than wide, *c.* half disc radius, approximating distally, contiguous. Arms inserted below disc. Arm combs present, double set, primary arm comb extending from genital slit, secondary comb opposing primary comb. Ventral interradial area covered in thick, overlapping scales. Oral shields large, pentagonal, slightly constricted by genital slits. Adoral shields contiguous. Oral papillae three, distalmost broadest, apical papillae pointed. Teeth same shape as apical papillae. Genital slits long, single, armed with small, rounded, blunt genital papillae. Dorsal arm plates fan-shaped, wider than long, contiguous proximally, becoming non-contiguous and as long as wide distally. Lateral arm plates large, separating both dorsal and ventral arm plates distally. Ventral arm plates fan-shaped, only contiguous on first 3-5 segments, becoming small distally. Arm spines three, short, thick, half segment length, tapering, blunt. Oral tentacle pores with up to seven rounded scales. Tentacle scales round, up to three basally, becoming one on remainder of arm.

Distribution and habitat
South Africa: Lambert's Bay (WC) to Amanzimtoti (KZN); depth range: 0-250m.
Habitat: Sand, shell, rock and mud.

Remarks
Endemic to South Africa (see Table 7.4). Although Madsen (1970) demoted *Dictenophiura anoidea* to *Ophiura* (*Dictenophiura*) *anoidea*, Clark and Courtman-Stock (1976) ignored this, even though they referred to Madsen's suggestion.

Clark (1923) stated that the holotype was at the Iziko South African Museum (SAMC A6438; False Bay, depth 40m), but this specimen was not located. Three paratypes were examined, namely SAMC A7473 (Great Fish Point, depth 90m), SAMC A7474 (Cove Rock, depth 79m) and SAMC A7505 (False Bay, depth 40m).

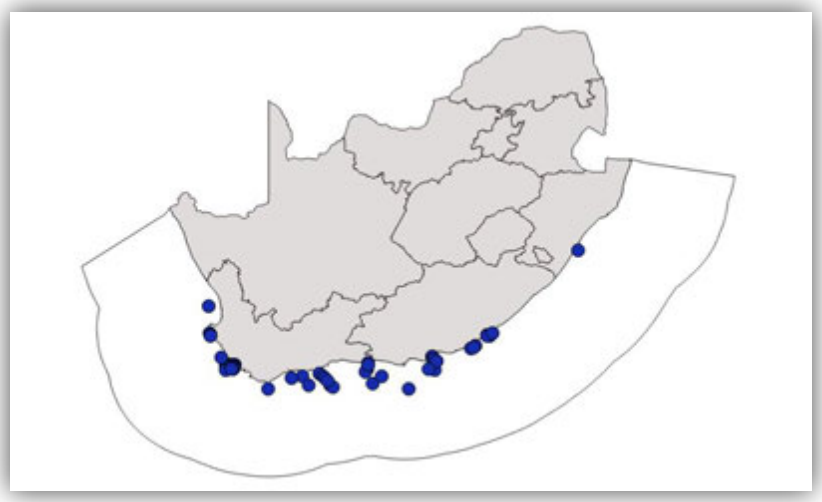

Figure 6.68. Distribution of *Ophiura* (*Dictenophiura*) *anoidea* in South Africa.

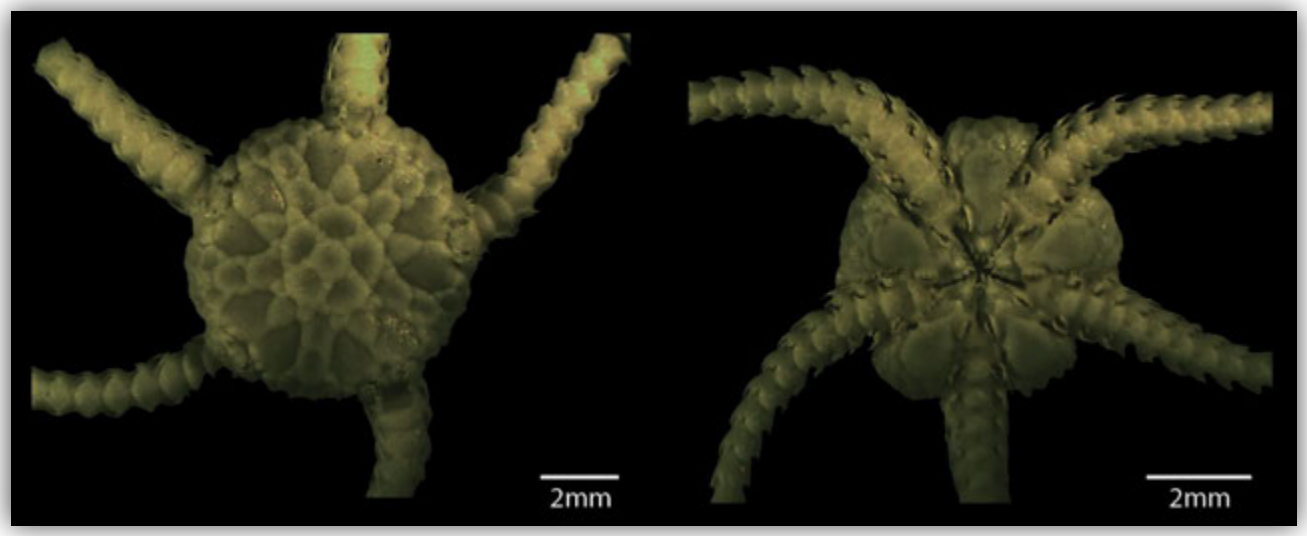

Figure 6.69. Dorsal (left) and ventral (right) views of *Ophiura* (*Dictenophiura*) *anoidea* (SAMC A084244).

Genus Ophiura (Ophiura) **Lamarck, 1816**

Diagnosis *- adapted from McKnight (2003).*

Primary dorsal disc scales not enlarged. Radial shields not contiguous. No double arm combs. Less disc scales than *Ophiura* (*Dictenoidea*).

Ophiura (Ophiura) trimeni **Bell, 1905**

Figs 6.70 and 6.71.

Ophiura trimeni Bell, 1905: 257-258, pl. 1, figs 3, 4; Clark, 1923: 360-361; Mortensen, 1933c: 384-385, fig. 84; Clark, 1974: 475-476.

Ophiura (Ophiura) trimeni: Clark and Courtman-Stock, 1976: 194-195, figs 224, 127, 107; Alva and Vadon, 1989: 841-842, figs c, d.

Gymnophiura novembris Hertz, 1927a: 72-73, pl. 6, figs 9, 10; Mortensen, 1933c: 393-394, fig. 89.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. = 3-9mm. Disc scales present, sometimes armed with small spines, primary rosette and central plates distinct in some specimens. Radial shields half disc radius, twice as long as wide, approximating distally, but not contiguous. Arm combs present, not always distinct and rubbed off easily, papillae short and stout. Ventral interradial area covered in small, overlapping scales. Oral shields large, pentagonal, constricted in vicinity of genital slits and strongly pointed on both sides, distal edge truncated. Adoral shields narrow, contiguous. Oral papillae three, distalmost broadest, apical papillae pointed. Teeth 3-5, same shape as apical papillae. Genital slits long, single and armed with small, rounded genital papillae. First 2-4 dorsal arm plates elongated, contiguous, wider than long, flat on distal side, becoming oval and small, distal side convex, becoming longer than wide, not contiguous, straight proximal edge. Ventral arm plates fan-shaped, as wide as long for first 2-3 segments, contiguous, becoming small and wider than long and semi-circular with median tip on distal edge. Lateral arm plates large, separating both dorsal and ventral arm plates distally, notch on distal sides adjacent to tentacle pores. Arm spines three, proximally spines twice segment length, one segment length distally. Spines irregular, in some specimens uppermost longest or thicker, remaining spines three, equal in size. Oral tentacle pores with up to ten rounded scales. Tentacle scales up to seven from segments 1-3, then on free segments decreasing from 3-1 distally, elongated but blunt.

Distribution and habitat
South Africa: off Platbaai (NC) to Sodwana Bay (KZN); depth range: 165-1647m.
Habitat: Sand, mud, rough bottom and sponge.

Remarks
Endemic to South Africa (see Table 7.4), with the distribution range extended to Sodwana Bay (Kendyl le Roux, pers. comm.), (see Table 7.3). Arm combs not distinct and can be easily missed (Mortensen, 1933c) or completely absent (Clark, 1923). The Iziko South African Museum material includes a ‘cotype’ (SAMC A7471; examined), type locality is west of Cape Town, depth 285-420m.

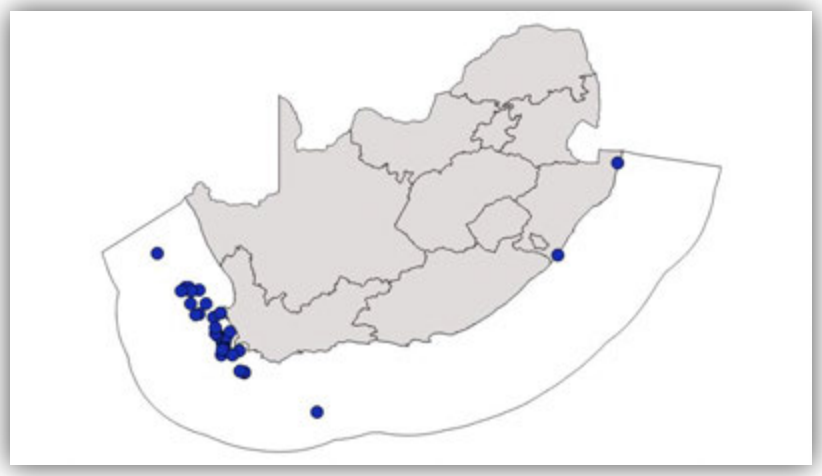

Figure 6.70. Distribution of *Ophiura* (*Ophiura*) *trimeni* in South Africa.

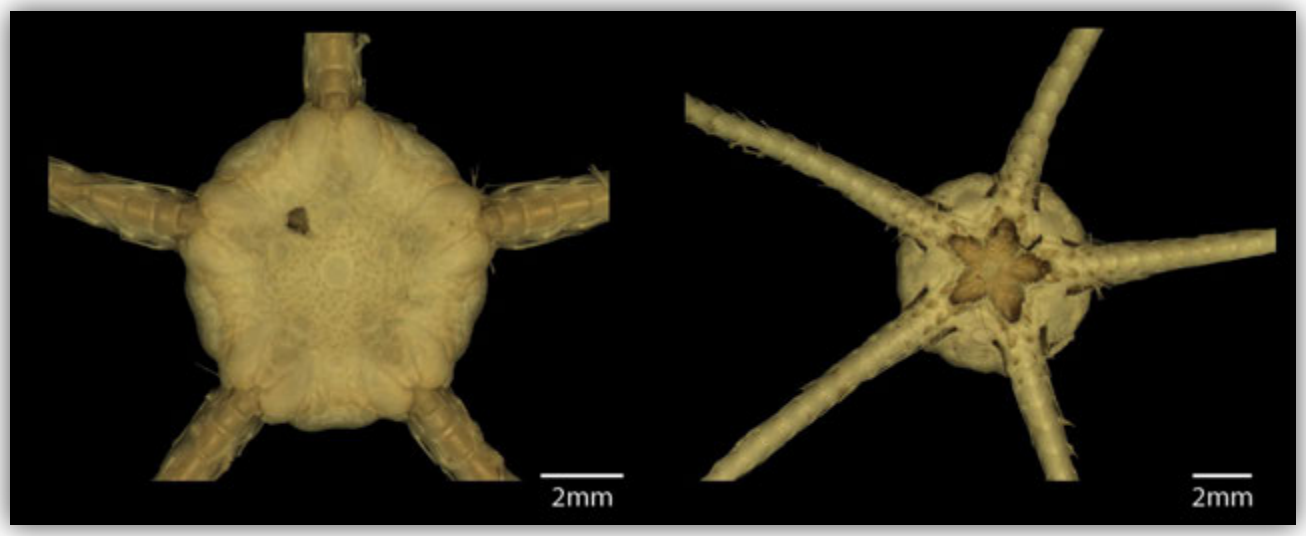

Figure 6.71. Dorsal (left) and ventral (right) views of *Ophiura* (*Ophiura*) *trimeni* (SAMC A084237).

Genus Ophiura (Ophiuroglypha) Hertz, 1927

Diagnosis - *adapted from McKnight (2003).*
Usually recognised as having three small arm spines, middle spine becoming an upturned hooklet on distal arm segments (Hertz, 1927a).

Ophiura (Ophiuroglypha) costata costata (Lyman, 1878)

Figs 6.72 and 6.73.

Ophioglypha costata Lyman, 1878: 76-77, pl. 4, figs 92-94; Lyman, 1882: 50, pl. 5, figs 1-3.
Ophiozona capensis Bell, 1905: 256-257, pl.1, figs 1, 2.
Ophiura costata: Clark, 1923: 357-358; Clark, A.M., 1952: 201; Ludwig, 1901: 925.
Ophiuroglypha capensis: Hertz, 1927a: 90-91, pl. 7, fig. 10.
Ophiura (*Ophiuroglypha*) *costata*: Mortensen, 1933c: 385-386, fig. 85a, d.
Ophiura (*Ophiuroglypha*) *costata costata*: Clark and Courtman-Stock, 1976: 195-196, 127, 107, figs 209, 216; Alva and Vadon, 1989: 828-829, 843, fig. 8e, f.

Diagnosis - *adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. = 11-23mm, D.D./A.L. = 1/4. Disc pentagonal, disc scales flat, irregular, primary rosette distinct in most specimens. Few scattered disc spines dorsally and ventrally. Radial shields longer than wide, oval, separated by large scales. Arm combs present, not distinct, widely separated, papillae stout, thick and short, restricted to bases of radial shields. Ventral interradial area covered in thick, large scales. Oral shields fairly large, triangular, with rounded distal edge. Adoral shields contiguous. Oral papillae irregular, 3-5 either side of pointed apical papillae. Teeth three, broad triangular, oral slits narrow, base of jaws sunken. Genital slits long, single and armed with squat, broadly attached genital papillae. Dorsal arm plates not carinate, elongated trapezoidal, contiguous, wider than long, becoming fan-shaped with rounded point on distal side, contiguous for *c.* half arm then separated by lateral arm plates. Ventral arm plates pentagonal, contiguous for one or two segments, becoming diamond-shaped, wider than long. Lateral arm plates large, separating both dorsal and ventral arm plates distally, arm spines low on plate. Arm spines three, very short. Second oral tentacle pores not in series with oral papillae, with up to 12 scales, then decreasing towards free segments, small and indistinct

from arm spines. Tentacle scales from segments 1-3, up to seven scales, then decreasing to one distally on free segments, elongated but blunt, adradial tentacle scale not enlarged.

Distribution and habitat
South Africa: off Orange River (NC) to Cape St Francis (EC); depth range: 43-1647m.
Habitat: Sand, mud, shells, stones, gravel and rock.

Remarks
Endemic to South Africa (see Table 7.4). The type material is in the Museum of Comparative Zoology (syntype: MCZ OPH-577), type locality Agulhas Bank, depth 275m.

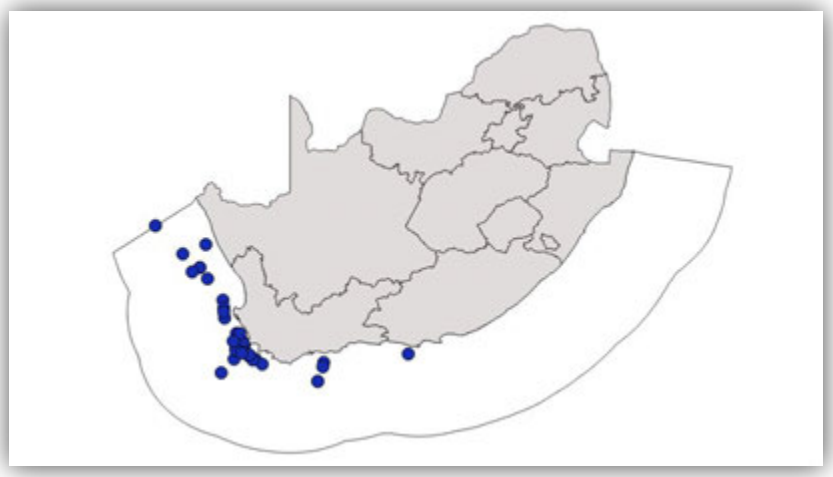

Figure 6.72. Distribution of *Ophiura* (*Ophiuroglypha*) *costata costata* in South Africa.

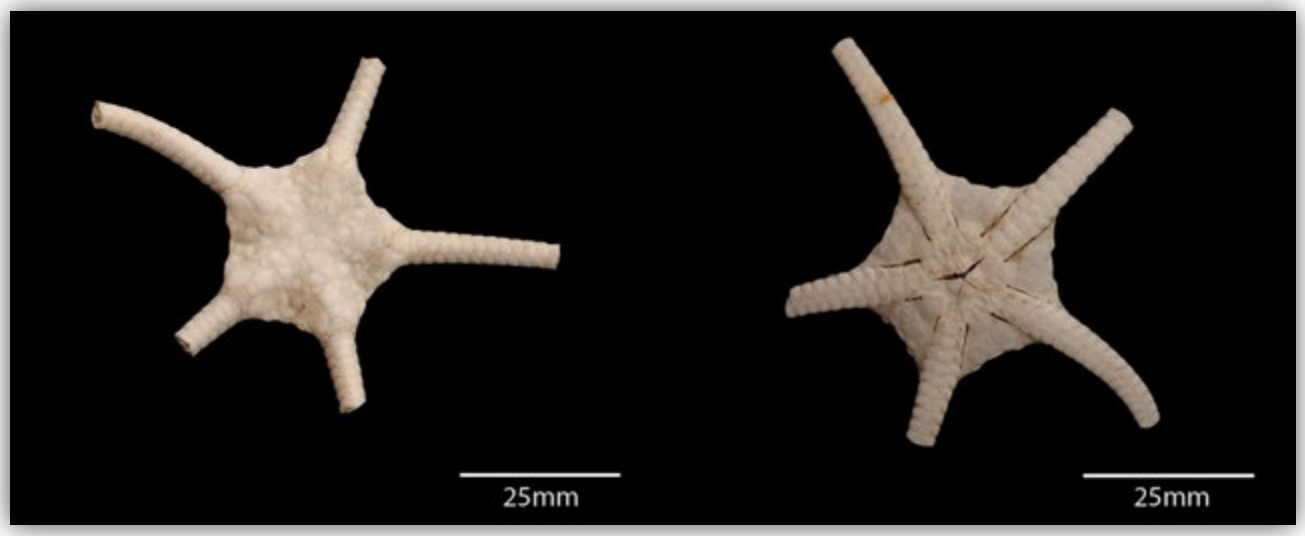

Figure 6.73. Dorsal (left) and ventral (right) views of *Ophiura* (*Ophiuroglypha*) *costata costata* (SAMC A23265).

***Ophiura (Ophiuroglypha) costata tumida* Mortensen, 1933**
Figs 6.74 and 6.75.

Ophiura (*Ophiuroglypha*) *tumida* Mortensen, 1933c: 387-388, fig. 85b, c, pl. 19, figs 22-23.
Ophiura (*Ophiuroglypha*) *costata tumida*: Clark and Courtman-Stock, 1976: 196, figs 223, 225, 127, 107; Alva and Vadon, 1989: 843.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. = 5-13mm, disc round, tumid, scales medium-sized, thick, irregular, primary rosette distinct. Radial shields slightly longer than wide, oval, separated interradially by single disc scale, just shorter than half disc radius. Ventral interradial area covered in four thick disc scales adjacent to two large genital plates, one wider than long on disc margin, two scales touching oral shield and smaller scale in between, often triangular in shape. Oral shields fairly large, pentagonal, rounded but flat distal edge. Adoral shields contiguous. Oral papillae irregular, 3-5 either side of pointed apical papillae, distalmost being broadest. Genital slits long, single and armed with squat, rectangular, broadly-attached genital papillae. Dorsal arm plates fan-shaped, not contiguous. Ventral arm plates bell-shaped, becoming triangular, distal edge straight, but rounded distally. Lateral arm plates large, separating both dorsal and ventral arm plates. Arm spines three, short, uppermost slightly longer. Oral tentacle pores not in series with oral papillae, with up to nine scales, then decreasing towards free segments from 3-1 tentacle scales and then one on remainder of arm, small and indistinct.

Distribution and habitat
Namibia, South Africa: Durban (KZN); depth range: 122-820m.
Habitat: No information available.

Remarks
Only recorded by the *Pickle* (1929) and *Valdivia* (1985). In this study, three specimens from the *Pickle* expedition were examined from the Iziko South African Museum (including two paratypes; SAMC A22369). All were in a poor condition and a count of tentacle scales could not be carried out with certainty. Type locality is off Durban, depth 232m.

It is uncertain that this species is correctly placed in *costata*, it is more likely to be from the *Scomba group* as defined by Paterson (Tim O'Hara, pers. comm.).

Figure 6.74. Distribution of *Ophiura* (*Ophiuroglypha*) *costata tumida* in South Africa.

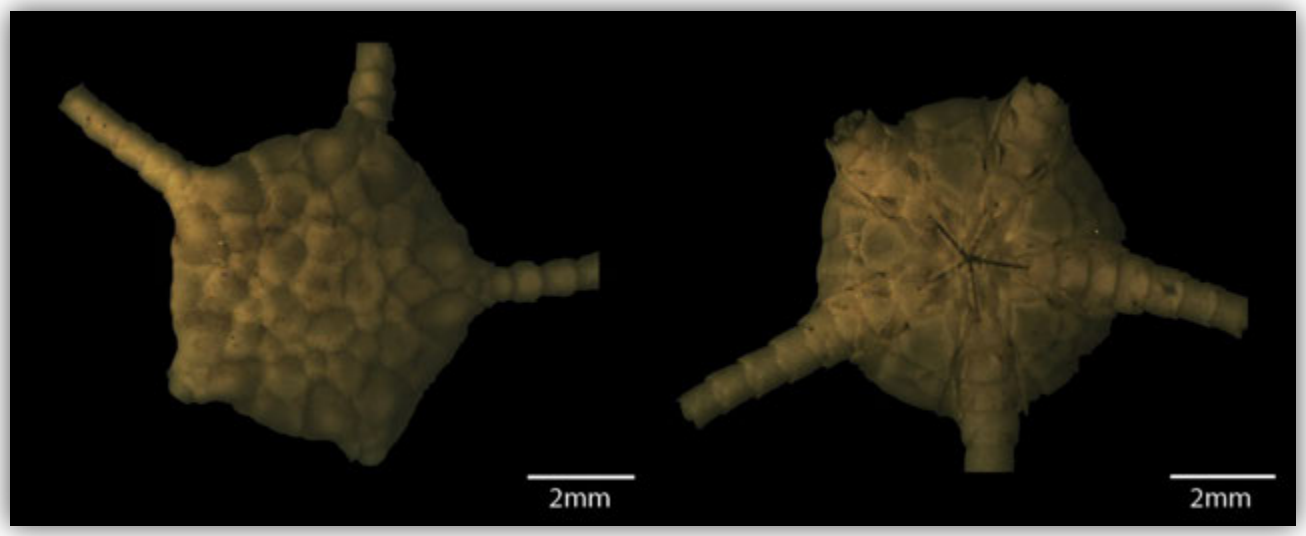

Figure 6.75. Dorsal (left) and ventral (right) views of *Ophiura* (*Ophiuroglypha*) *costata tumida* (SAMC A22370).

Ophiura (Ophiuroglypha) irrorata irrorata **(Lyman, 1878)**

Figs 6.76 and 6.77.

Ophioglypha irrorata Lyman, 1878: 73-74, pl. 4, figs 106-108; Lyman, 1882: 47-48, pl. 5, figs 7-9; Koehler, 1914a: 18-20, pl. 1, figs 3, 4.
Ophioglypha orbiculata Lyman, 1878: 74-75, pl. 4, figs 103-105.
Ophioglypha grandis Verrill, 1894: 293-295.
Ophioglypha involuta Koehler, 1897: 295-297, pl. 6, figs 16-18; Koehler, 1899: 15-16, pl. 8, figs 61-63.
Ophioglypha tumulosa Lütken and Mortensen, 1899: 120-122, pl. 1, figs 9-13.
Ophiura irrorata: Ludwig, 1901: 925; Clark, 1911: 62-64; Clark, 1915a: 320; Matsumoto, 1917: 277-278; Koehler, 1922b: 380; Clark, 1923: 358-359; Mortensen, 1927:235; Clark, H.L., 1939: 109; Madsen, 1955: 11; Madsen, 1956: 26; Madsen, 1967: 130; Martynov and Litvinova, 2008: 79-80, pl. 1c.
Homalophiura irrorata: Koehler, 1922a: 55-57, pl. 86, figs 15, 16.
Ophiuroglypha irrotata: Hertz, 1927a: 86-87 (*lapsus calami*).
Ophiura (*Ophiuroglypha*) *irrorata*: Mortensen, 1933c: 388; Clark and Courtman-Stock, 1976: 107, 127, 197, fig. 217.
Ophiura (*Ophiuroglypha*) *irrorata irrorata*: Mortensen, 1933b: 86-87; Paterson, 1985: 123-124, figs 46, 47.

Diagnosis *- adapted from Lyman (1882), Clark and Courtman-Stock (1976) and Paterson (1985).*
D.D. = 8-15mm. Disc pentagonal, disc scales small and irregular, primary rosette distinct. Radial shields round to oval, separated by scales. Arm combs present, widely separated, papillae stout and short. Ventral interradial area covered in thick, medium-sized, overlapping scales. Oral shields pentagonal, flat distal edge, fairly large. Adoral shields contiguous. Oral papillae irregular, mostly pointed, 6-8 either side of pointed apical papillae, in series with first set of oral tentacle scales. Teeth 3-4, similar in shape to apical papillae. Genital slits long, single and armed with squat, broadly attached genital papillae. Dorsal arm plates trapezoid, contiguous for most of arm, becoming fan-shaped with round distal edge. Ventral arm plates bell-shaped proximally, becoming diamond-shaped, wider than long with rounded distal edge. Accessory ventral arm plate adjacent to lateral arm plates present on basal segments. Lateral arm plates large, with three arm spines, very small, upper spine well-separated from other two spines. Oral tentacle pores, with up to 15 scales, then decreasing towards free segments to about 3-4 scales and further down the arm to one, small and not distinct from arm spines. Tentacle scales from segments 1-3 up to seven, then decreasing on free segments

from 3-1 distally, barely distinct from segment 10-12, adradial tentacle scale slightly enlarged which may appear similar to an supplementary ventral arm plate.

Distribution and habitat

Almost cosmopolitan, absent in Arctic seas (Clark, H.L., 1939; Paterson, 1985; Martynov and Litvinova, 2008), South Africa: off Saldanha Bay (WC) to off Quoin Point (WC), depth range: 403-7340m (Martynov and Litvinova, 2008).
Habitat: *Globigerina* and grey ooze.

Remarks

Anophiura simplex (Ophiolepididae) has a similar arm spine arrangement with two arm spines widely separated from the third spine. The type material is in the Museum of Comparative Zoology (syntype: MCZ OPH-615), type locality south of Cape Agulhas, depth 3475m.

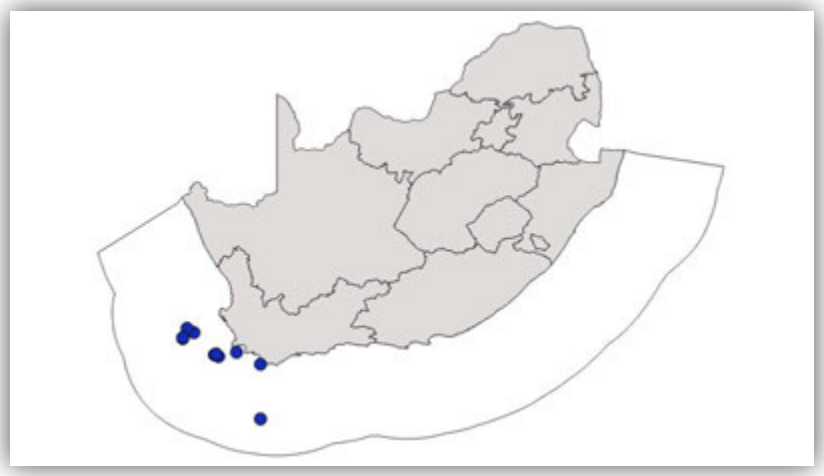

Figure 6.76. Distribution of *Ophiura* (*Ophiuroglypha*) *irrorata irrorata* in South Africa.

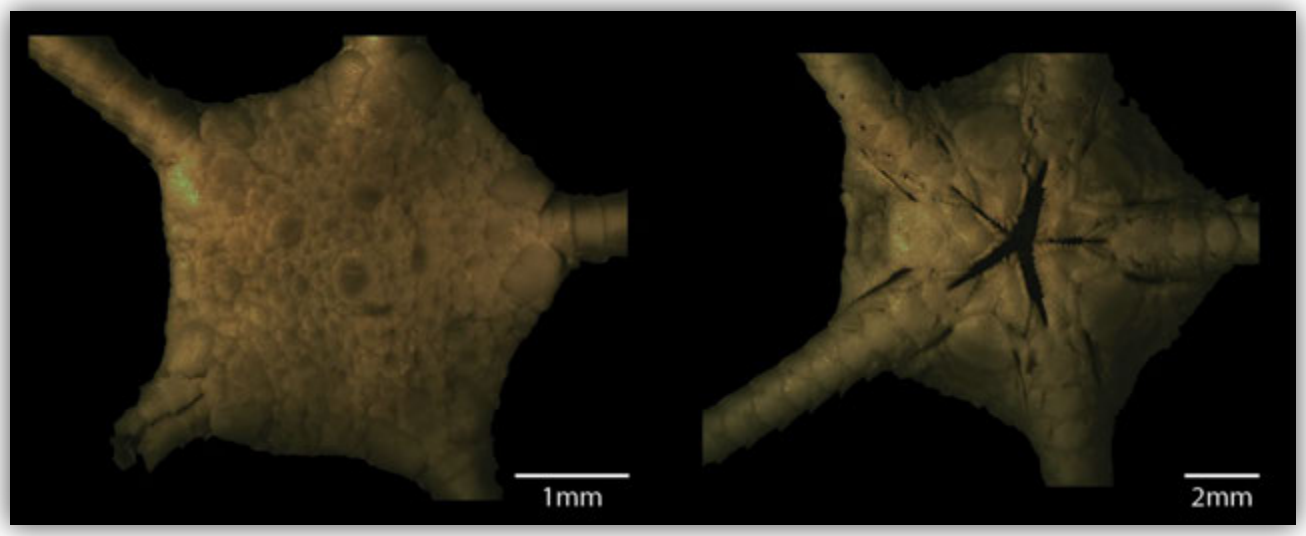

Figure 6.77. Dorsal (left) and ventral (right) views of *Ophiura* (*Ophiuroglypha*) *irrorata irrorata* (SAMC A23341).

***Ophiura (Ophiuroglypha) schmidtotti* (Hertz, 1927)**
Figs 6.78 and 6.79.

Ophiuroglypha schmidt-otti Hertz, 1927a: 91-93, fig. 5, pl. 7, figs 11, 12.
Homalophiura schmidtotti: Clark, 1977: 136, 144-145.
Ophiura (*Ophiuroglypha*) *schmidtotti* Paterson, 1985: 136, 151.

Diagnosis *- adapted from Clark (1977) and Paterson (1985).*
D.D. up to 9mm, D.D./A.L. = 1/2.5. Disc round, disc scales thick, medium-sized, irregular, primary rosette distinct and large central disc scale. Radial shields triangular or oval, only just touching distally unless separated by row of scales, longer than wide, *c.* one-quarter to one-third disc radius in length. Arm combs distinct, papillae large, square. Oral shields rounded pentagonal, slightly convex on distal edge, slightly wider than long, fairly large. Adoral shields relatively large, contiguous. Oral papillae 3-6 either side of apical papillae, all broad. Genital plates distinct, single, slits long, armed with short, squat, broad genital papillae. Dorsal arm plates triangular, contiguous for first 2-3 segments, wider than long basally. Ventral arm plates bell-shaped, then becoming wider than long and fan-shaped, only first two plates contiguous, remaining plates not contiguous. Lateral arm plates large, separating both dorsal and ventral arm plates. Arms relatively short. Arm spines three, short, blunt, equal in length, not tapering, one hooked and turned upwards. Oral tentacle pores in series with oral papillae, with up to ten scales, then decreasing to single, small tentacle scale distally.

Distribution and habitat
East Africa and Indonesia (Hertz, 1927a), South Africa: St Lucia (KZN); depth range: 693-1644m.
Habitat: No details available.

Remarks
A single specimen was examined, on which all arms were broken and tentacle scale count could not be undertaken. The type material is in the Museum of Natural History at the University of Berlin (ZMB Ech 7009, ZMB Ech 7010, ZMB Ech 7011 and ZMB Ech 7012, type locality is Sumatra and East Africa, depth 1143m (Hertz, 1927a).

Figure 6.78. Distribution of *Ophiura* (*Ophiuroglypha*) *schmidtotti* in South Africa.

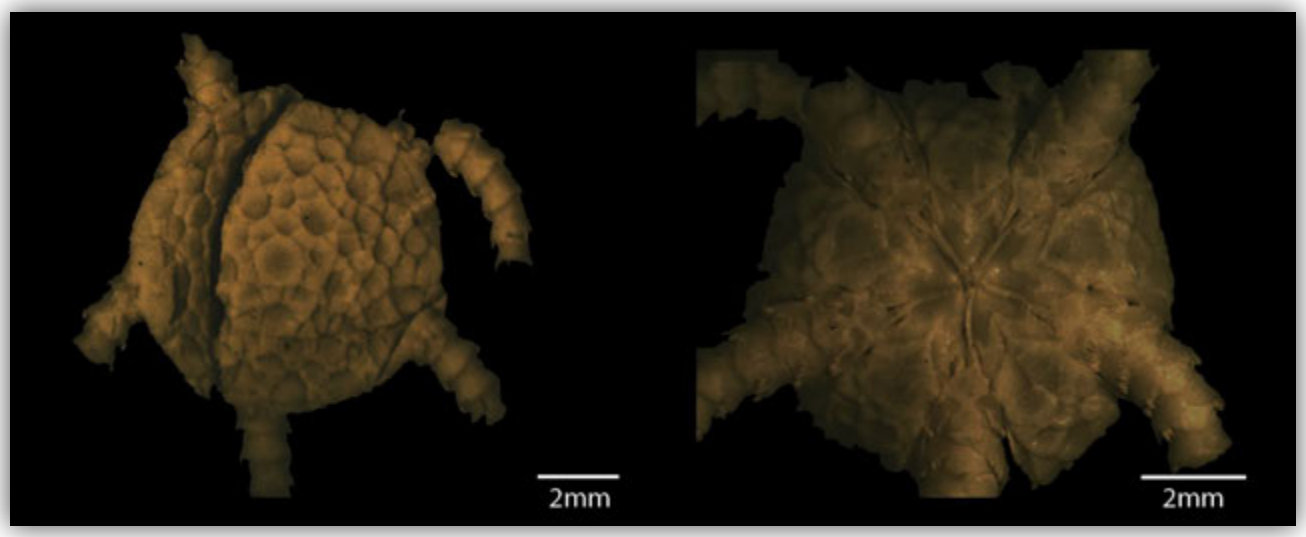

Figure 6.79. Dorsal (left) and ventral (right) views of *Ophiura* (*Ophiuroglypha*) *schmidtotti* (SAMC A22811).

Infraorder Gnathophiurina (Matsumoto, 1915)

Family AMPHILEPIDIDAE Matsumoto, 1915

Diagnosis *- adapted from Matsumoto (1915).*
Oral shields large. Teeth triangular, not stout. Oral papillae present. Dental papillae absent. Distal vertebrae often incompletely divided longitudinally by a series of pores.

***Genus Amphilepis* Ljungman, 1867**

Diagnosis *- adapted from Ljungman (1867b) and Lyman (1882).*
Disc flat, large, with naked overlapping scales, radial shields large. Teeth large, no dental papillae. Oral papillae small, unequal, scale-like. Arms flattened, slender. Arm spines usually three, short, tapering. Genital slits single.

***Amphilepis scutata* Mortensen, 1933**
Figs 6.80 and 6.81.

Amphilepis scutata Mortensen, 1933c: 372-373, fig. 76; Clark, 1974: 464; Clark and Courtman-Stock, 1976: 103, 119, 146-147, fig. 155; Clark, 1977: 135.

Diagnosis *- adapted from Mortensen (1933c).*
D.D. = 3-6mm. Disc round, flat, scales moderate in size, overlapping, primary rosette and central plates distinct. Radial shields moderately large, triangular, *c.* half disc radius, approximating distally but not contiguous, separated by elongated, triangular scales. Ventral interradial area covered in smaller, overlapping scales. Oral shields moderately large, triangular with rounded edges. Adoral shields contiguous. Oral papillae two, distalmost elongated and much longer than proximal-most. Teeth triangular and long. Genital plates large, thin. Arms moderately long, thin. Dorsal arm plates semi-circular with straight edge on distal edge, wider than long, not contiguous, appear restricted at vertebrae joints. Ventral arm plates bell-shaped, rounded on distal side, pointed on proximal side, longer than wide, not contiguous, restricted at tentacle pores. Arm spines three, slender, pointed, middle spine slightly longer. Tentacle pores large, tentacle scales absent.

Distribution and habitat
South Africa: off Duyker Eiland (WC) to Black Rock (KZN); depth range: 175-810m.
Habitat: Sandy mud, with polychaetes.

Remarks
Endemic to South Africa (see Table 7.4). Cherbonnier and Guille (1978) synonymised *Amphilepis scutata* with *Amphilepis mobilis* Koehler, 1904a. The drawings of *A. mobilis* in Koehler (1904a) and Cherbonnier and Guille (1978) are quite different from the specimens examined and the drawings of *A. scutata* in Mortensen, 1933c. The drawings of *A. mobilis* have round disc scales separating the radial shields, an indistinct primary rosette and lack a central disc scale. In *A. scutata*, radial shields approximate distally and the separating scales are triangular. The primary rosette and central disc scale are distinct. Therefore, *A. scutata* and *A. mobilis* are considered to be separate species here.

A specimen of *A. scutata* was dredged at 440m offshore of Duyker Eiland on the west coast of South Africa. Although this is the most modern record of this species (2007), it is a peculiar distribution record, because other specimens were found in subtropical waters in KZN. The holotype is in Natural History Museum of Denmark (ZMUC OPH-264) and the type locality is off Durban, depth 411m.

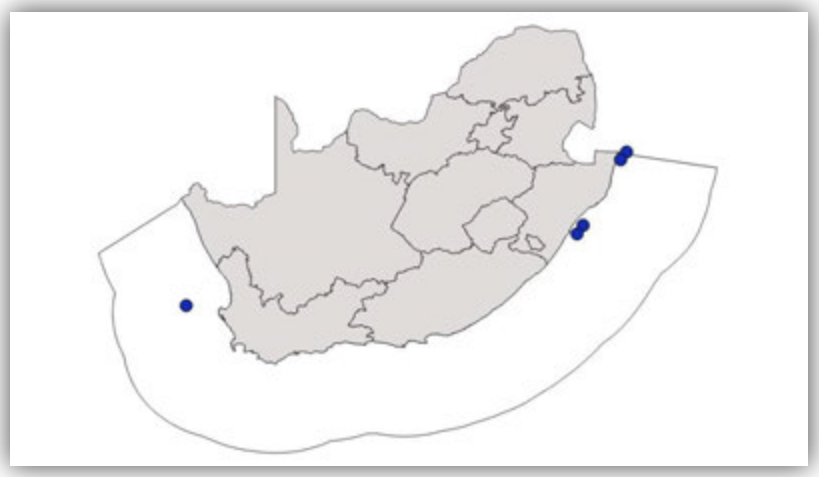

Figure 6.80. Distribution of *Amphilepis scutata* in South Africa.

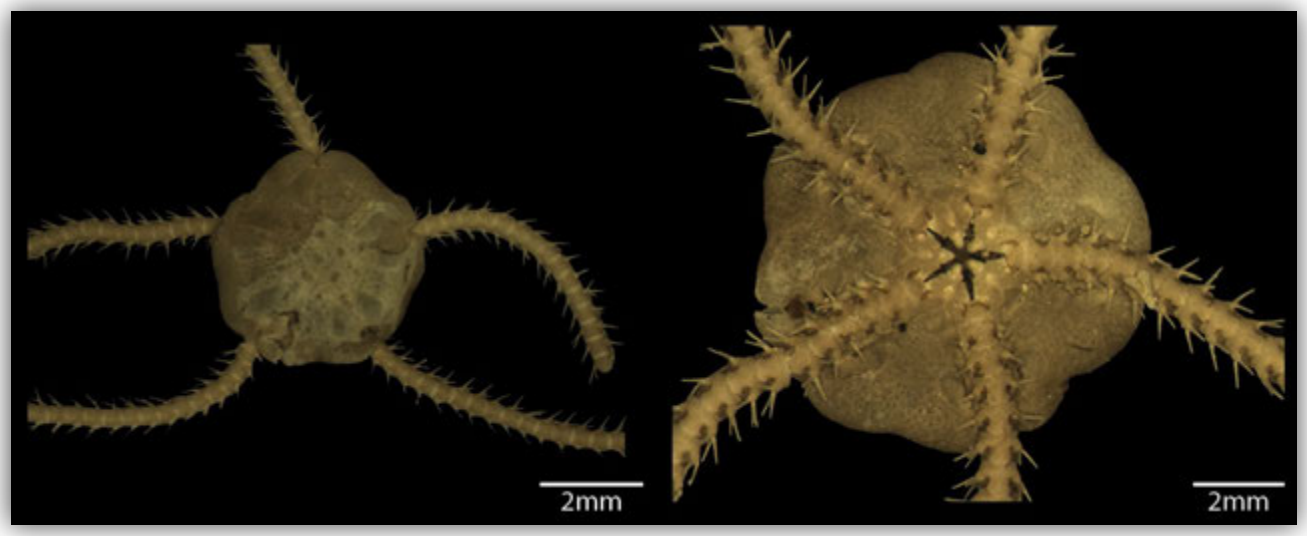

Figure 6.81. Dorsal (left) and ventral (right) views of *Amphilepis scutata* (SAMC A073834).

Family AMPHIURIDAE Ljungman, 1867

Diagnosis *- adapted from Matsumoto (1915) and Clark and Courtman-Stock (1976).*
Disc scaling distinct, sometimes armed with small spines and obscured by thick skin. Two infradental papillae present on apex of jaw. Teeth broad. Arms moderately stout, dorsal and ventral arm plates well-developed. Arm spines usually tapering, appearing smooth. Tentacle scales round, small, 1-2, rarely absent.

Genus Amphilimna **Verrill, 1899**

Diagnosis *- adapted from Verrill (1899b), Devaney (1974) and Thomas (1975).*
Disc with notch at base of each arm, disc scales may have spines or granules. Radial shields variable in size and shape, largely in contact. Oral papillae 2-6. Ventral arm plates abruptly widen distally. Arm spines 6-10, ones under disc flattened and fused to form a flange. Tentacle pores very large and open. Tentacle scales spiniform, round or flat, two (rarely one).

Amphilimna cribriformis **Clark, 1974**
Figs 6.82 and 6.83.

Amphilimna cribriformis Clark, 1974: 442-444, fig. 1a-d; Thomas, 1975: 131, 132, 137; Clark and Courtman-Stock, 1976: 122, 165, 166, figs 182, 183; Liao, 1989: 342; Olbers *et al.*, 2015: 92, pl. 2C, D.

Diagnosis *- adapted from Clark (1974) and Clark and Courtman-Stock (1976).*
D.D. up to 6.5mm. Disc round, indented radially, uniformly white both dorsally and ventrally due to preservation. Dorsal and ventral disc covered in medium-sized fine disc scales with scattered, tapering, sharp spinelets, no change in spinelet, scale density or size on disc margin. Radial shields long, narrow, spines may be absent. Oral shields triangular with rounded angles, as long as wide, widest distally. Adoral shields restricted to lateral edge of oral shield, triangular with inner margin curved, not contiguous. Jaws slightly elongated, 2-4 asymmetrical apical oral papillae, three spinose distal papillae, two distalmost being on edge of adoral shield. Teeth single, broad with small elongated oral tentacle scale either side. Genital plates large, lie at angle in which they appear to be overlapping, each plate with two stout spines at dorsal end. Arms long and thin, first 2-4 dorsal arm plates short, compressed or rudimentary, narrow. First free arm plate fan-shaped with convex distal edge, as long as wide, narrowly contiguous, plates translucent, porous and brittle with underlying structure visible. First ventral arm plate appearing triangular, adjacent to adoral shields, second arm plate with straight distal edge, broader between tentacle pores. Ventral arm plates thereafter with slight convex edge, becoming concave distally, narrowing adjacent to tentacle pores, longer than wide. Arm spines six, with first 7-9 arm plates with flattened, webbed arm spines, forming a wing-like flange which excludes lowermost spine. Beyond disc, arm spines free, flattened, becoming round and tapering distally. Tentacle scales two on segments 1- *c.*10, outer scale small, inner scale spinose, resembling an arm spine, becoming reduced and eventually completely lost, single tentacle scales after segment ten.

Distribution and habitat
Mozambique (Clark, 1974; Clark and Courtman-Stock, 1976), South Africa: Umhlali (KZN) to North of Prince's Grant (KZN); depth range: 86-200m.
Habitat: Sandy mud.

Remarks
Olbers *et al.* (2015) stated that the holotype in the Iziko South African Museum (SAMC A22784) had disintegrated and they suggested a neotype be erected from the paratype SAMC A22787. Additional paratypes (examined) located in Iziko South African Museum include SAMC A22790, SAMC A22786,

SAMC A22785, SAMC A22788, SAMC A22787, SAMC A22789 and SAMC A22791. Type locality off Ballito, depth 118m.

Figure 6.82. Distribution of *Amphilimna cribriformis* in South Africa.

Figure 6.83. Dorsal (left) and ventral (right) views of *Amphilimna cribriformis* (SAMC A22787).

***Amphilimna valida* (H.L. Clark, 1939)**

Figs 6.84 and 6.85.

Anamphiura valida Clark, H.L., 1939: 70-72, figs 26A, 27; Clark, 1974: 478-479, fig. 16; Clark and Courtman-Stock, 1976: 104, 166-167.
Amphilimna valida Thomas, 1975: 134-135, 137.

Diagnosis *- adapted from Thomas (1975) and Clark and Courtman-Stock (1976).*
D.D. = 4-5mm, D.D./A.L.-1/2. Disc pentagonal, primary rosette distinct, disc scales large and convex with some smaller overlapping scales away from primary rosette. Disc with scattered spines, mostly on disc margin and ventral interradial areas. Radial shields short, moderately wide, one-third of disc radius, contiguous on proximal side and gaping distally. Genital plates with spines distal to radial shields which give appearance of arm combs. Genital slits long, genital plates large, no genital papillae. Ventral interradial area covered in overlapping scales. Oral shields diamond-shaped, broad with rounded angles. Adoral shields contiguous. Oral papillae 2-3, infradental papillae on apex of the jaw, flanked by first oral tentacle scale with a diastema before 2-3 oral papillae attached to adoral

shield. Arms short. First dorsal arm plate small, broadly in contact, remaining plates fan-shaped, narrowly in contact. Ventral arm plates constricted by large tentacle pores, distal angle obtuse, contiguous. Arm spines 5-6, short, conical, lowest about one segment length, uppermost shortest, half segment length, spines on first one or two arm segments are flattened and form a flange. Tentacle scales one, large rounded, sometimes two on first segment.

Distribution and habitat
Zanzibar, Tanzania (Clark, H.L., 1939), South Africa: off Durban (KZN) to off Umhlanga River mouth (KZN); depth range: 238-350m.
Habitat: Sandy mud.

Remarks
Thomas (1975) argued that *Anamphiura valida* belongs to the genus *Amphilimna* Verrill, 1899 and that *Amphilimna* is an ophiacanthid and not an amphiurid as currently considered. Clark and Courtman-Stock (1976) agreed that *Amphilimna* was indeed an ophiacanthid, but did not agree that *Amphilimna* valida (Clark, 1939) was a valid combination and referred to the South African specimen as *Anamphiura valida*. In this study, *Anamphiura valida* was treated as a synonym to *Amphilimna valida* in accordance with Stöhr (2007a).

Clark (1974) recorded the locality of the South African specimen as near the Tugela River mouth, but the co-ordinates are in fact closer to the Umhlanga River mouth. In addition, Clark (1974) placed this species as *Anamphiura valida* into the family Amphiuridae and classified it as *incertae sedis.*

The holotype is in the Natural History Museum in London (NHMUK 1948.5.26.87) and the type locality is off Zanzibar, 238-293m. In addition, the Smithsonian Institution, National Museum of Natural History holds five specimens from Durban (USNM E42872), collected by the *Anton Bruun*, depth 350m.

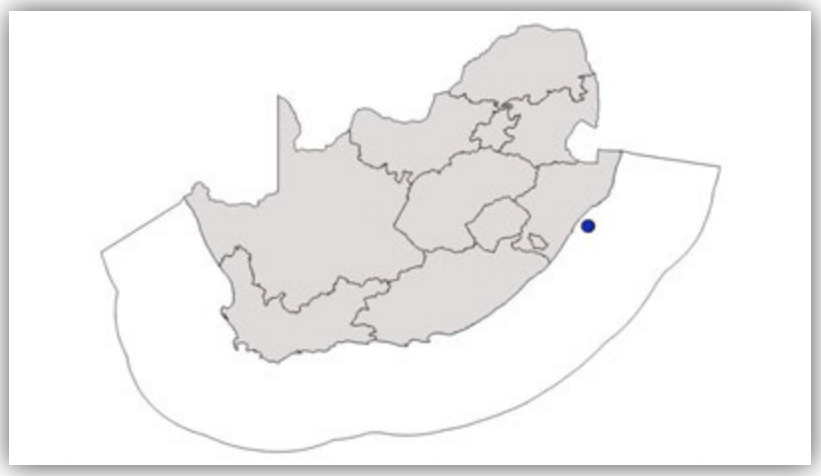

Figure 6.84. Distribution of *Amphilimna valida* in South Africa.

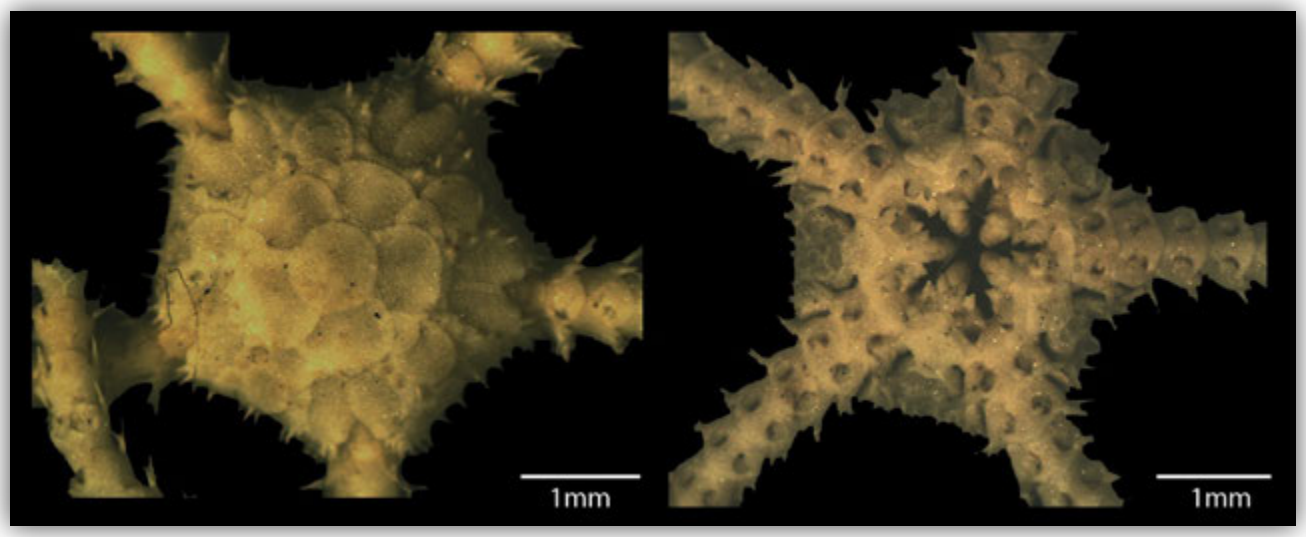

Figure 6.85. Dorsal (left) and ventral (right) views of *Amphilimna valida* (SAMC A23231).

Genus Amphioplus Verrill, 1899

Diagnosis *- adapted from Clark (1970), Clark and Courtman-Stock (1976) and Verrill (1899b).*
Disc usually fully scaled, lacking armament, primary rosette usually distinct. Radial shields contiguous distally, or at least for some of their length, rarely fully separated. Jaws armed with three or four papillae either side, may be spaced or in a series incapable of closing the oral slit. Tentacles scales one or two, rarely absent or rudimentary.

Three subgenera of *Amphioplus* are recognised as follows:
Amphioplus: first oral tentacle scale present in oral slit;
Lymanella: four superficial papillae in a straight row, the third enlarged, and no distinct oral tentacle scale; and
Unioplus: only three papillae and a single oral tentacle scale, more or less in sequence.

Amphioplus (Amphioplus) pectinatus Mortensen, 1933

Figs 6.86 and 6.87.

Amphioplus pectinatus Mortensen, 1933c: 367-368, fig. 72.
Amphioplus (*Amphioplus*) *pectinatus*: Clark, 1974: 456-459, fig. 8; Clark and Courtman-Stock, 1976: 102, 119, 148, fig. 153.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Mortensen (1933c).*
D.D. = 5-6mm. Disc scales moderately coarse, primary rosette sometimes distinct, disc fully scaled ventrally, scales finer than dorsal. Radial shields slender, length *c.* more than one-third disc radius, wedge of scales between them, contiguous or nearly so distally. Plate below and distal to each radial shield hosting a disc scale with a comb of 3-5 hyaline thorns. Oral shields spearhead-shaped, longer than wide, truncated distally. Adoral shields contiguous. Oral papillae four with a diastema between first infradental papillae and second, revealing second oral tentacle scale which are in sequence with papillae, third oral papillae slightly enlarged. Arms slender. Dorsal arm plates triangular with rounded edges, almost elliptical or hexagonal, only just contiguous. Ventral arm plates pentagonal or squarish when proximal angle truncated, contiguous. Arm spines 3-6, tapering. Tentacle scales two.

Distribution and habitat
South Africa: Bluff (KZN) to North of Prince's Grant (KZN); depth range: 77-410m.

Habitat: Mud and sand.

Remarks

Endemic to South Africa (see Table 7.4). No whole specimens were examined. Most of the specimens examined by Clark (1974) were disc-less or damaged. The syntypes are in the Natural History Museum of Denmark (ZMUC OPH-240 and ZMUC OPH-235) and the type locality is off Durban, depth 410m.

Figure 6.86. Distribution of *Amphioplus* (*Amphioplus*) *pectinatus* in South Africa.

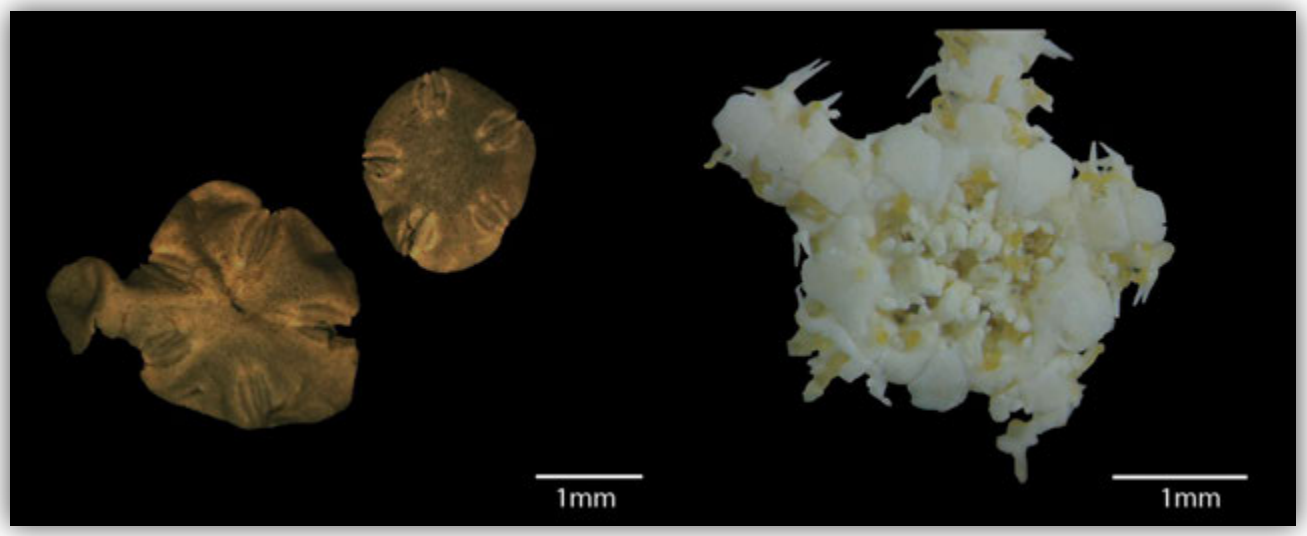

Figure 6.87. Dorsal (left) and ventral (right) views of *Amphioplus* (*Amphioplus*) *pectinatus* (SAMC A23220).

***Amphioplus (Lymanella) depressus* (Ljungman, 1867)**

Figs 6.88 and 6.89.

Amphipholis depressa Ljungman, 1867b: 312.
Amphipholis hastata Ljungman, 1867b: 313.
Ophiophragmus affinis Duncan, 1887: 89-90, pl. 8, figs 4-6.
Amphiura relicta Koehler, 1898b: 69, pl. 4, figs 37, 38; Koehler, 1900: 4, pl. 16, figs 15, 16.
Amphioplus relictus: Clark, 1915a: 256; Clark, 1938: 251.
Amphioplus depressus: Clark, 1915a: 254; Clark, 1946: 205; James, 1970: 142-144, fig. 1g-k.
Amphioplus hastatus: Clark, 1915a: 257; Clark, 1923: 331; Clark, H.L., 1939: 75-76; Day and Morgans, 1956: 308; Clark, 1967: 47; Vine, 1986: 195.

Amphioplus (*Lymanella*) *hastatus*: Clark, 1970: 51, 54-55, fig. 9p, q; Clark and Rowe, 1971: 80, 102, fig. 24a; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 81, 83-86, figs 36, 37; Sloan *et al.*, 1979: 101; Richmond, 2002: 326.
Amphioplus (*Lymanella*) *depressus*: Clark, 1970: 54; Clark and Rowe, 1971: 102; Gibbs *et al.*, 1976: 117-118; Baker, 1979: 46; Liao and Clark, 1995: 190, fig. 88; Olbers *et al.*, 2015: 92-93, pl. 2E, F.

Diagnosis *- adapted from Clark (1970) and Clark and Rowe (1971).*
D.D. up to 10mm. D.D./A.L. = 1/6. Primary rosette may or may not be distinct. Disc scales moderate in size, overlapping, central scales may be larger than peripheral scales. Disc margin vertical, sometimes with small projections or thorns. Radial shields contiguous for at least half their lengths, may be half disc radius or less. Oral shields narrow, diamond-shaped, longer than wide, adoral shields triangular, contiguous. Oral papillae four, arranged in a continuous row forming a straight line, third papilla slightly enlarged. Arm length approximately 6-7 times disc diameter. Dorsal arm plates rectangular, wider than long, distal margin convex or straight, contiguous. Ventral arm plates pentagonal, flat distally, narrowly contiguous. Arm spines up to three, blunt-pointed, *c.* as long as segment. Tentacle scales two, large, covering pore.

Distribution and habitat
Mozambique, Madagascar, Red Sea, Persian Gulf, Arabian Sea, Bay of Bengal, Indonesia, Japan, Philippines, Australia, Fiji (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Baker, 1979; Rowe and Gates, 1995), South Africa: Durban (KZN) to Sodwana Bay (KZN); depth range: 0-160m.
Habitat: Associated with seagrass (*Syringodium isoetifolium* and *Cymodocea serrulata*), mud, sand and detritus (James, 1970; Cherbonnier and Guille, 1978).

Remarks
Olbers *et al.* (2015) noted this was a new record for South Africa and synonymised *Amphioplus* (*Lymanella*) *hastatus* with *Amphioplus* (*Lymanella*) *depressus* based on the South African material.

The syntypes are in the Swedish Museum of Natural History (*Amphipholis depressa*: SMNH-Type-1430) and the type locality is between Batavia and Singapore, depth unknown.

Figure 6.88. Distribution of *Amphioplus* (*Lymanella*) *depressus* in South Africa.

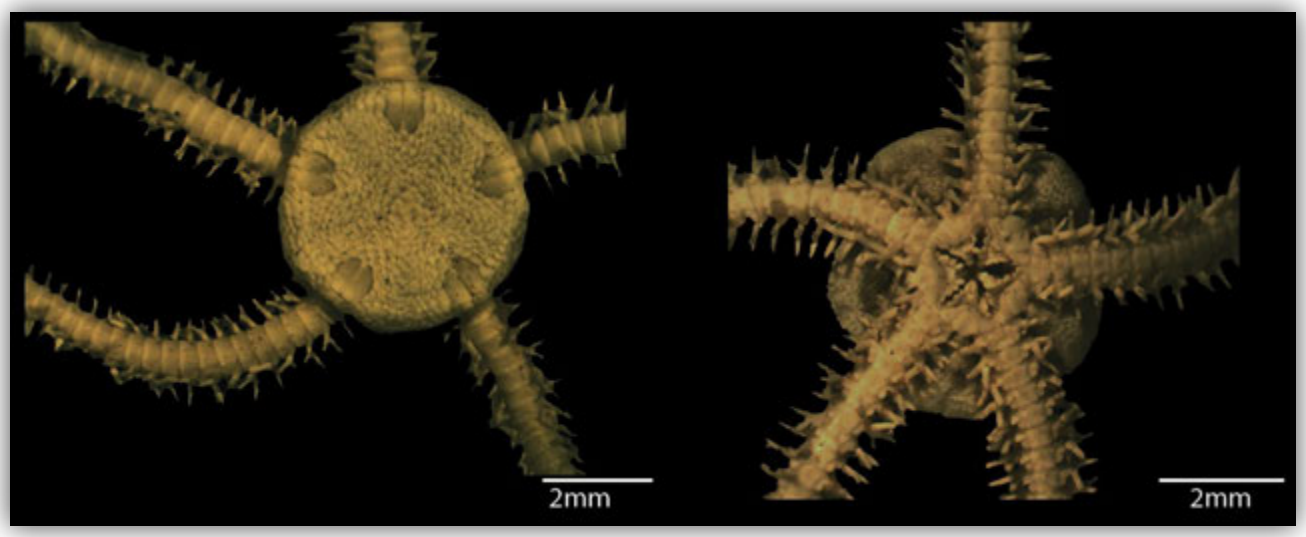

Figure 6.89. Dorsal (left) and ventral (right) views of *Amphioplus* (*Lymanella*) *depressus* (SAMC A74078).

Amphioplus (Lymanella) furcatus **Mortensen, 1933**

Figs 6.90 and 6.91.

Amphioplus furcatus Mortensen, 1933c: 370-372, fig. 75; Mortensen, 1940: 96.
Amphioplus (*Lymanella*) *furcatus*: Clark, 1970: 52; Clark, 1974: 452-453; Clark and Courtman-Stock, 1976: 102, 117, 149, fig. 149; Cherbonnier and Guille, 1978: 81, 82-83, fig. 35.

Diagnosis *- adapted from Mortensen (1933c) and Cherbonnier and Guille (1978).*
D.D. up to *c*. 8mm, D.D./AL = 1/5-8. Primary rosette may be distinct, disc scaling fine. Edge of disc vertical, with small spines on disc margin. Radial shields almost fully contiguous, one-third to half disc radius, 13 scales between radial shields interradially. Oral shields diamond-shaped, longer than wide, rounded distal lobe, inner angle rounded. Adoral shields triangular, contiguous. Oral papillae four in straight row, third papillae enlarged. Arms slender. Dorsal arm plates oval, wider than long, narrowly contiguous. Ventral arm plates pentagonal, broad, narrowly contiguous. Arm spines three, slender, tapering and pointed, *c.* equal to segment length. Tentacle scales two, one on ventral arm plate very large.

Distribution and habitat
Madagascar (Cherbonnier and Guille, 1978), South Africa: Zinkwazi (KZN) to Amatikulu (KZN); depth range: 30-70m.
Habitat: Mud.

Remarks
Clark (1970) transferred *Amphioplus furcatus* to the subgenus *Lymanella*. A single specimen from the Tugela River mouth was examined during this study. The syntypes are in the Natural History Museum of Denmark (ZMUC OPH-363) and the type locality is off the south head, Tugela River, depth 46m.

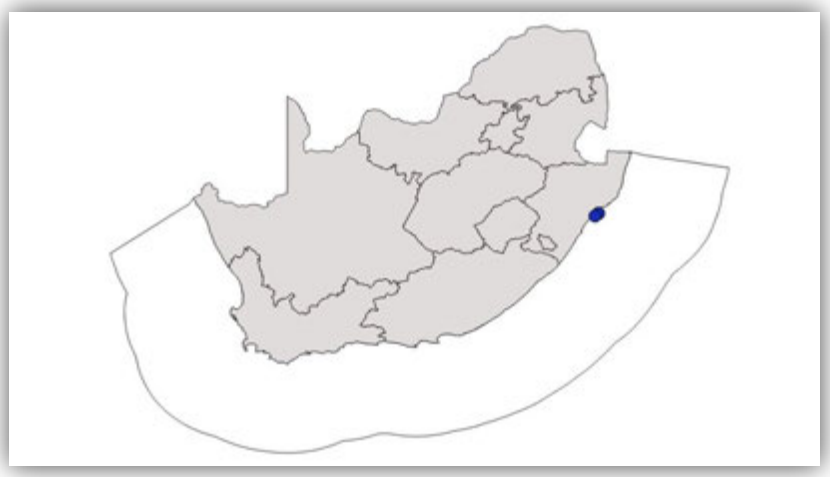

Figure 6.90. Distribution of *Amphioplus* (*Lymanella*) *furcatus* in South Africa.

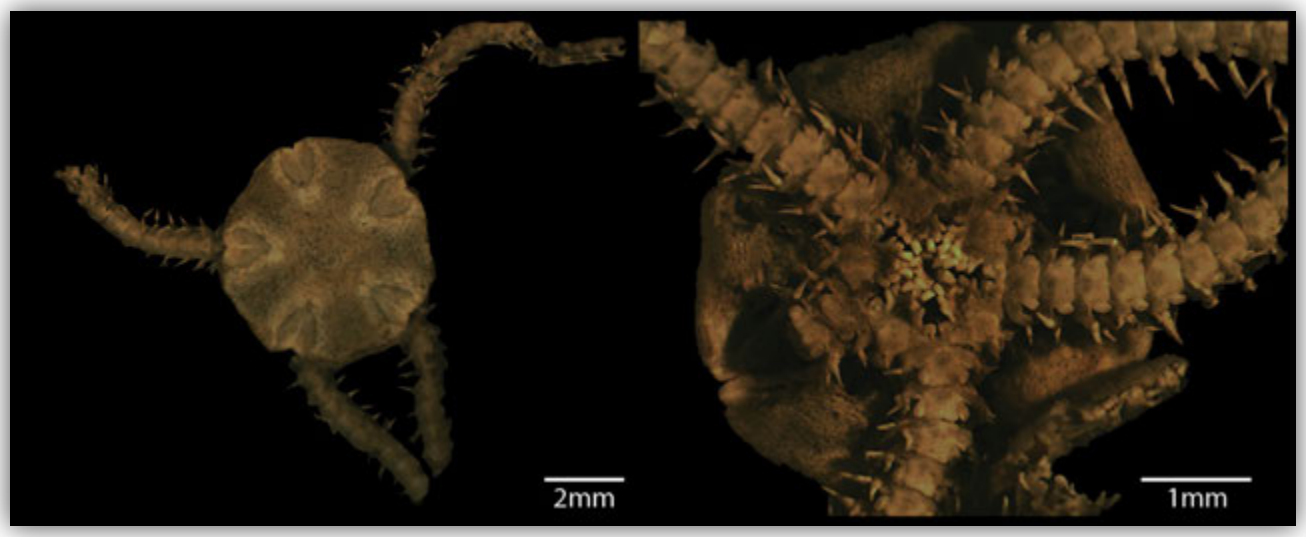

Figure 6.91. Dorsal (left) and ventral (right) views of *Amphioplus* (*Lymanella*) *furcatus* (SAMC A23219).

***Amphioplus (Lymanella) integer* (Ljungman, 1867)**

Figs 6.92 and 6.93.

Amphipholis integra Ljungman, 1867b: 313.
Amphiura integra Lyman, 1882: 148; Koehler, 1904b: 65-66, figs 16, 17.
Amphioplus integer: Clark, 1923: 330-331; Mortensen, 1933c: 368-370, figs 73, 74; Tortonese, 1936: 219; Stephenson *et al.*, 1937: 380; Balinsky, 1957: 11; Macnae and Kalk, 1962: 107; Macnae and Kalk, 1969: 106; Day *et al.*, 1970: 80; Vine, 1986: 195.
Amphioplus (*Lymanella*) *integer*: Clark 1970: 52; Clark and Rowe, 1971: 80, 103; Clark, 1974: 453-455, fig. 6; Clark and Courtman-Stock, 1976: 102, 117, 149-150, fig. 150; Cherbonnier and Guille, 1978: 81, 86-87, fig. 38; Richmond, 2002: 326; Mbongwa, 2013: 15; Olbers *et al.*, 2014: 15, pl. 2D.

Diagnosis *- adapted from Cherbonnier and Guille (1978) and Clark and Courtman-Stock (1976).*
D.D. up to 6mm. D.D./A.L. = 1/8. Primary rosette distinct. Disc scales moderate in size, overlapping. Radial shields contiguous for most of their lengths, some have wedge of scales, 7-11 scales between radial shields interradially. No small thorny projections on disc margin. Oral shields spearhead-shaped, rounded distally, longer than wide. Adoral shields triangular, contiguous. Oral papillae four, arranged in a continuous row forming a straight line, third papillae slightly enlarged. Dorsal arm plates oval, wider than long, distal margin convex, narrowly contiguous. Ventral arm plates pentagonal, distal sides flat or

slightly convex, narrowly contiguous. Arm spines up to three, blunt, stout, *c*. as long as segment length, proximal-most spines may be longer than segment, uppermost spatulate flattened, becoming cigar-shaped. Tentacle scales two, large, covering pore. Colour in life grey to dirty white (Balinsky, 1957).

Distribution and habitat

Western Indian Ocean, Red Sea (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Richmond, 2002), South Africa: Lambert's Bay (WC) to Sodwana Bay (KZN); depth range: 0-82m.
Habitat: Rock, sand, mud, shell, kelp beds and limestone.

Remarks

Clark and Courtman-Stock (1976) noted a large variation in length and breadth of radial shields in species from South Africa and Mozambique and also that the middle arm spine of specimens from False Bay exceeds the segment length more than in the other specimens. The syntypes are in the Swedish Museum of Natural History (*Amphipholis integra*: SMNH-Type-1432) and the type locality is Port Natal (Durban), depth unknown.

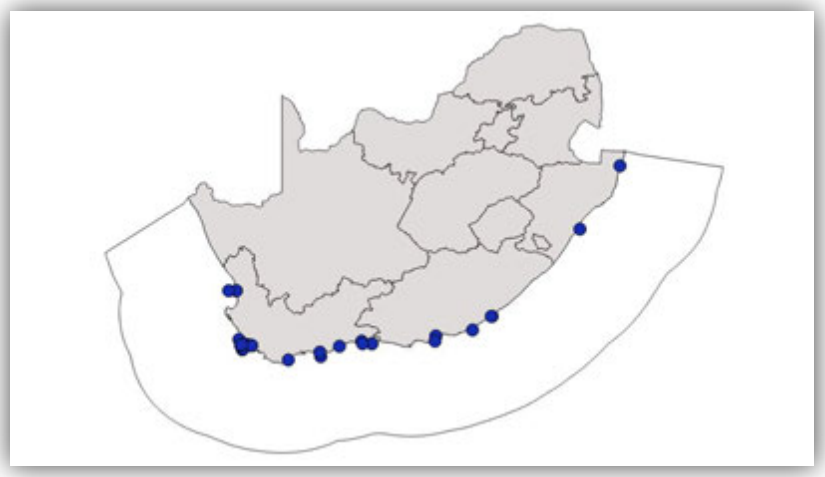

Figure 6.92. Distribution of *Amphioplus* (*Lymanella*) *integer* in South Africa.

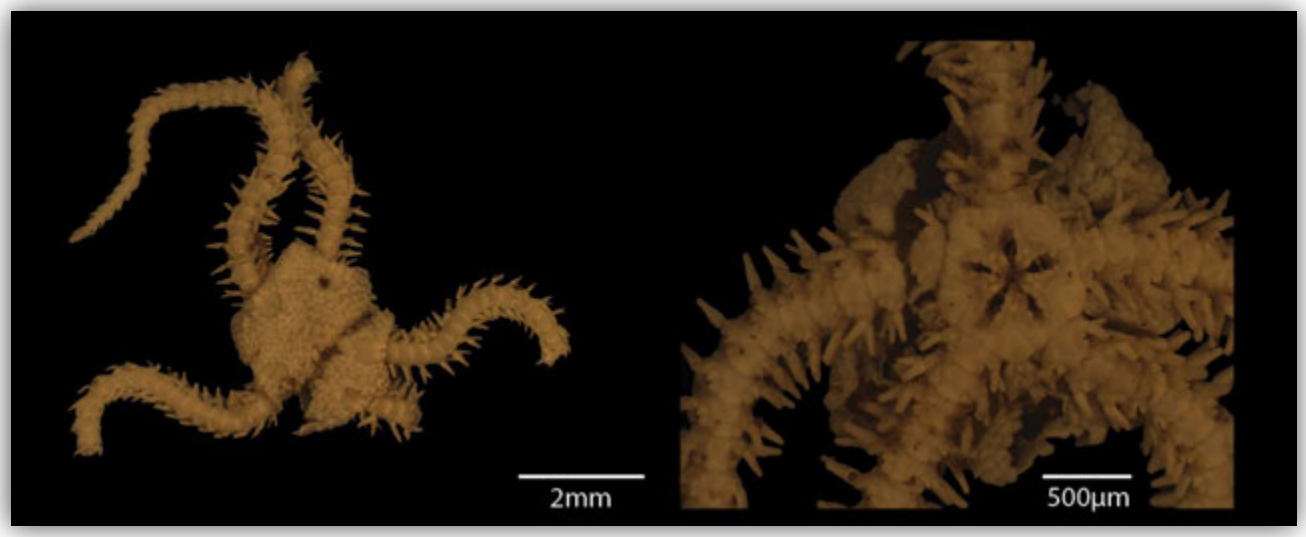

Figure 6.93. Dorsal (left) and ventral (right) views of *Amphioplus* (*Lymanella*) *integer* (DNSM ECH23E).

Amphioplus (Unioplus) falcatus Mortensen, 1933

Figs 6.94 and 6.95.

Amphioplus falcatus Mortensen, 1933c: 365-367, figs 70, 71, pl. 19, figs 18, 19; Fell, 1962: 16.
Amphioplus (*Unioplus*) *falcatus*: Clark, 1974: 455-456, fig. 7; Clark and Courtman-Stock, 1976: 102, 119, 150, figs 151, 152.

Diagnosis *- adapted from Mortensen (1933c).*

D.D. up to 7mm, D.D./AL = 1/1.5. Primary rosette not distinct. Disc scales coarse, overlapping, moderate in size, ventral interradial scales finer. Radial shields narrow, sickle-shaped (falcate), contiguous only on distalmost side, three rows of scales between radial shields interradially, longer than half disc radius. Oral shields triangular, angles rounded, can vary substantially in width. Adoral shields triangular, contiguous. Oral papillae three, with a single oral tentacle scale in series, second oral papillae on lower level than other two, third papillae larger, broader. Dorsal arm plates oval, wider than long, distal margin convex, narrowly contiguous. Ventral arm plates fan-shaped, truncated proximally, distal sides flat or slightly convex, contiguous. Arm spines three, pointed, middle one longest, ending in small hook. Tentacle scales one, large, elongated, triangular.

Distribution and habitat

South Africa: Durban (KZN) to Prince's Grant (KZN); depth range: 57-411m.
Habitat: Sandy mud, coarse sand, coral and mud with polychaetes.

Remarks

Endemic to South Africa (see Table 7.4). Fell (1962) originally described *Unioplus* as a new genus primarily based on the single tentacle scale, using *Amphioplus falcatus* as the type specimen. The paratype is at Iziko South African Museum (SAMC A22381; examined) while the syntypes are at the Natural History Museum of Denmark (ZMUC OPH-362), the type locality is Durban, depth 411m.

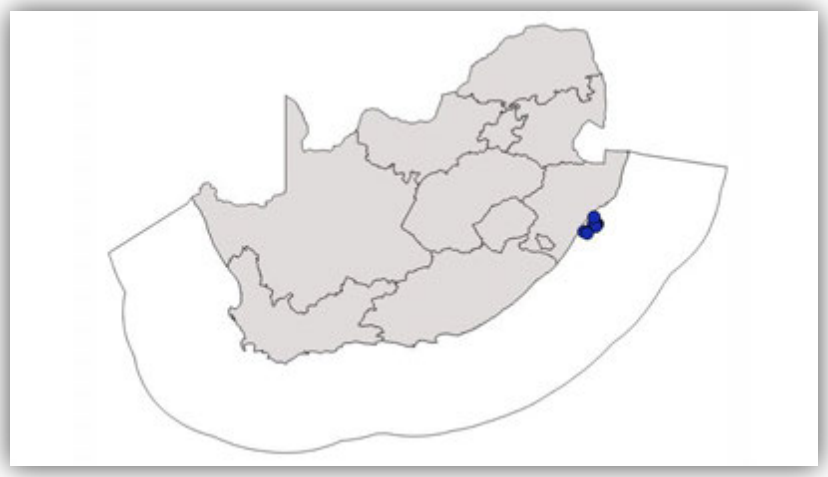

Figure 6.94. Distribution of *Amphioplus* (*Unioplus*) *falcatus* in South Africa.

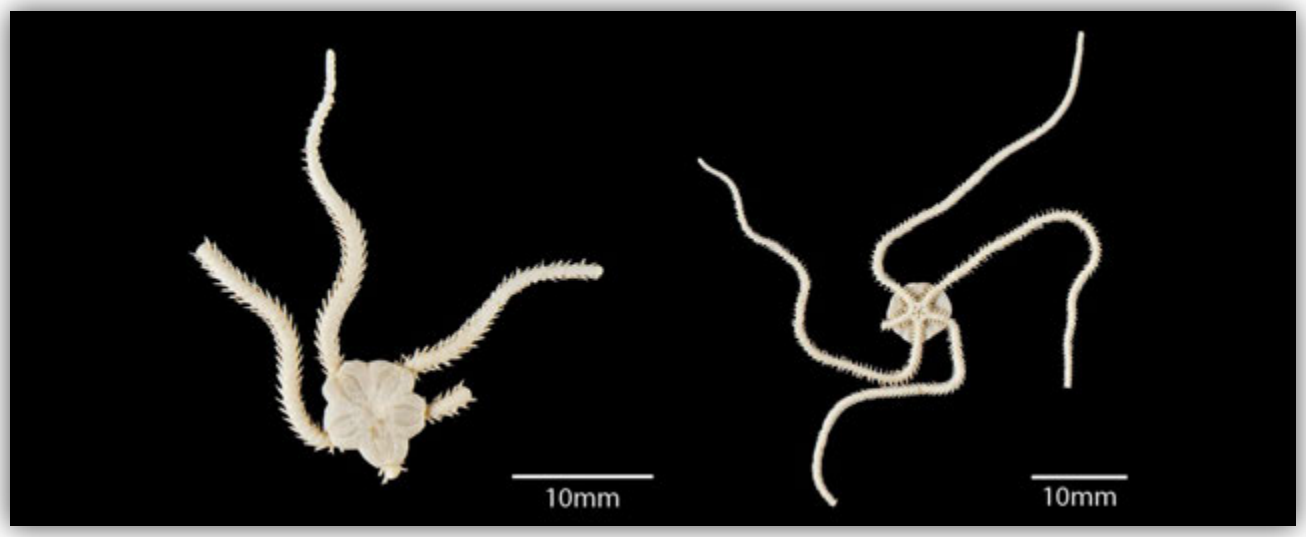

Figure 6.95. Dorsal (left) and ventral (right) views of *Amphioplus* (*Unioplus*) *falcatus* (ZMUC OPH-362).

Genus Amphipholis Ljungman, 1867

Diagnosis *- adapted from Clark (1970) and Clark and Courtman-Stock (1976).*
Disc completely scaled, lacking spines, scaling rarely reduced on ventral side. Rosette often distinct, radial shields usually more contiguous for more than half their length, jaws armed with three oral papillae in continuous series, outermost very broad and opercular, no oral tentacle scale visible. Arm spines 3-4. Usually two tentacle scales, sometimes one, rarely none.

Amphipholis similis Mortensen, 1933

Figs 6.96 and 6.97.

Amphipholis similis Mortensen, 1933c: 363-364, fig. 69; Clark, 1974: 450, fig. 5a; Clark and Courtman-Stock, 1976: 151; Milne, 2012: 153; Mbongwa, 2013: 15.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. = 2-3mm. Primary rosette distinct with scales between them. Disc scales large, coarse, overlapping, ventral interradial scales similar. Radial shields fairly wide, D-shaped, almost completely contiguous, length *c.* one-third disc radius. Oral shields rhombic with rounded angles, short distal lobe, as long as wide. Adoral shields contiguous. Oral papillae three in series, outermost very broad and opercular, no oral tentacle scale visible. Genital papillae absent. Dorsal arm plates oval, wider than long, distal margin convex, barely contiguous. Ventral arm plates fan-shaped, as long as wide, distal sides flat or slightly convex, narrowly contiguous. Arm spines three, tapering and pointed, shorter than segment length. Tentacle scales two, fairly large.

Distribution and habitat
South Africa: Gouritz (WC) to Sodwana Bay (KZN); depth range: 8-138m.
Habitat: Sand, shells and stones.

Remarks
Endemic to South Africa (see Table 7.4). During this study, distribution was extended north-east from Amatikulu to Sodwana Bay (see Table 7.3).

This species may be confused with small specimens of *Amphioplus* (*Lymanella*) *integer* by the presence of the under-developed or concealed fourth papilla (Clark, 1974). *Amphipholis* can be

distinguished from other Amphiuridae by the third oral papilla being more than twice as broad as the second papilla. In addition, *Amphipholis similis* does not have enlarged tentacle scales and arm spines are all shorter than corresponding segment. Arms on specimens missing.

Holotype in the Natural History Museum of Denmark (ZMUC OPH-275) and the type locality is off Durban, depth 64m.

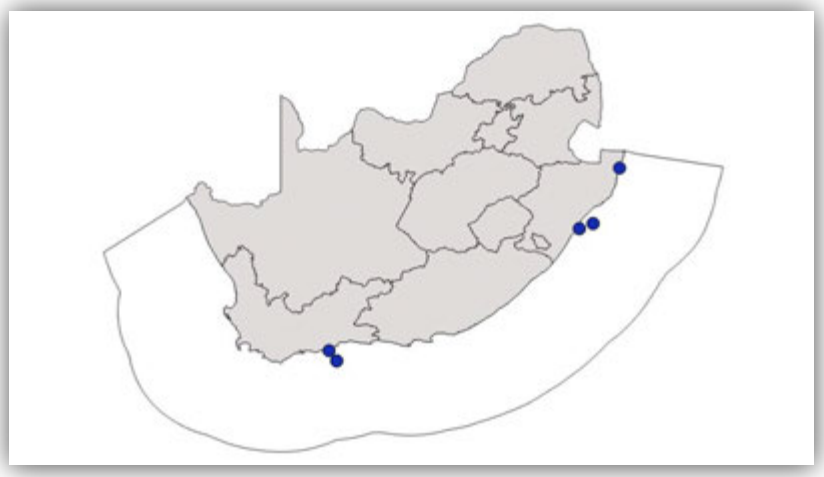

Figure 6.96. Distribution of *Amphipholis similis* in South Africa.

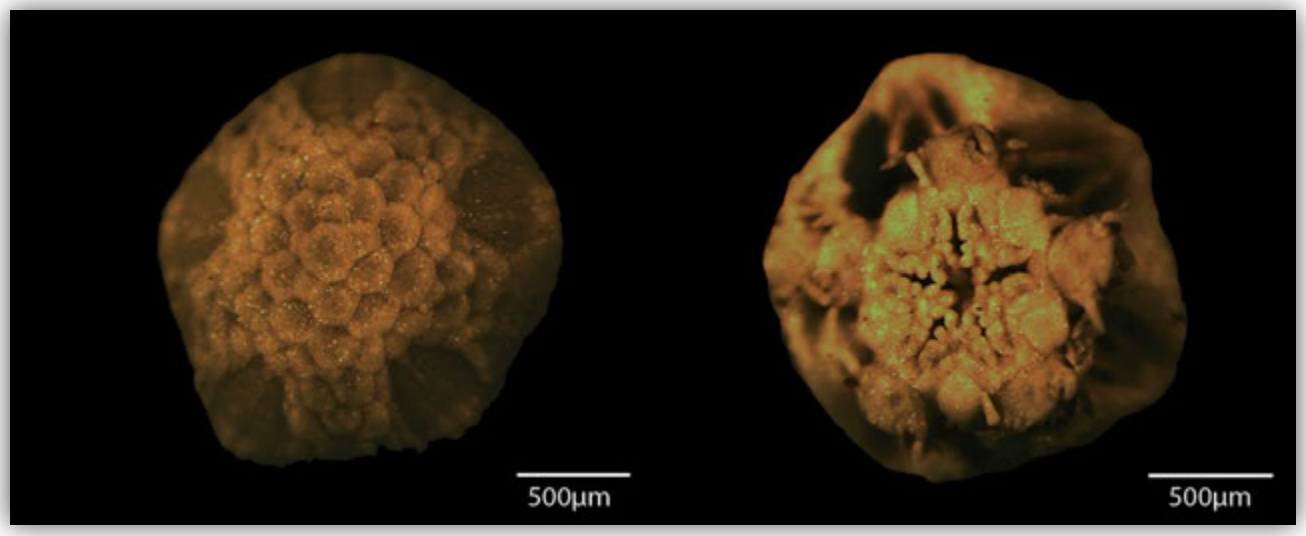

Figure 6.97. Dorsal (left) and ventral (right) views of *Amphipholis similis* (SAMC A74058).

***Amphipholis squamata* (Delle Chiaje, 1828)**

Figs 6.98 and 6.99.

Asterias squamata Delle Chiaje, 1828: 74, 77.
Ophiolepis squamata: Müller and Troschel, 1842: 92.
Amphipholis kinbergi Ljungman, 1872: 646.
Amphiura squamata: Lyman, 1882: 136.
Amphipholis squamata: Verrill, 1899b: 24; Koehler, 1914a: 66; Clark, 1923: 330; Mortensen, 1927: 221-222, fig. 125; Koehler, 1930: 102-103; Mortensen, 1933c: 364-365; Stephenson *et al.*, 1937: 380; Bright, 1937a: 63; Eyre *et al.*, 1938: 110; Murakami, 1943a: 172; Clark, 1946: 202; Clark, A.M., 1952: 200; Balinsky, 1957:10; Kalk, 1958: 200, 207, 215, 237; Macnae and Kalk, 1958: 106; Day, 1959: 544; Grindley and Kensley, 1966: 12; Clark,

1967: 47; Clark, 1970: 30-31; Day *et al.*, 1970: 81; Penrith and Kensley, 1970: 234; Clark and Rowe, 1971: 80, 81, 99; Devaney, 1974: 125-126; Clark and Courtman-Stock, 1976: 102, 117, 151-152, fig. 138; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 105-106, fig. 48; Irimura, 1982: 41, fig. 26, pl. 2, fig. 1; Marsh, 1986: 70; Alva and Vadon, 1989: 829; Sastry, 1991: 376, pl. 3, fig. 15; Liao and Clark, 1995: 194-195, fig. 92; Rowe and Gates, 1995: 346; Richmond, 2002: 326; Laguarda-Figueras *et al.*, 2009: 200-201, pl. 82; Milne, 2012: 155; Mbongwa, 2013: 15.
Ophiactis minor Döderlein, 1910: 253, pl. 5, fig. 3.
Amphipholis japonica Matsumoto, 1915: 71; Matsumoto, 1917: 186-189, fig. 49; Irimura, 1979: 3.
Amphioplus squamata: Macnae and Kalk, 1962: 111.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 20mm. Primary rosette not always distinct. Disc scales moderately large, coarse, overlapping, ventral interradial scales similar. Radial shields fairly wide, D-shaped, mostly contiguous, *c.* one-third disc radius. Oral shields rhombic with rounded angles, wider than long. Adoral shields triangular, contiguous. Oral papillae three, in continuous series, outermost very broad, no oral tentacle scale visible. Genital papillae absent. Dorsal arm plates rounded-triangular, wider than long, distal margin convex, barely contiguous. Ventral arm plates pentagonal, wider than long, distal sides flat or slightly concave, narrowly contiguous. Arm spines up to four, short, tapering, pointed. Tentacle scales two, moderate in size. Colour in life very dark, almost black (Mortensen, 1933c), beige to black (Deheyn and Jangoux, 1999) or greyish with a bright spot ringed by a darker area on the distal sides of each pair of radial shields (Clark and Courtman-Stock, 1976).

Distribution and habitat
Cosmopolitan, South Africa: off Orange River (NC) to Kosi Bay (KZN); depth range: 0-1962m.
Habitat: Rock, sand, shell, mud, kelp, associated with Patellidae, *Zonaria* and *Zostera.*

Remarks
This cosmopolitan species occurs throughout South Africa in a variety of habitat types in depths up to 720m. Syntypes of the synonym *Amphipholis japonica* (MCZ OPH-3893) and *Amphipholis kinbergi* (MCZ OPH-1407) are in the Museum of Comparative Zoology. The whereabouts of the holotype is unknown (Rowe and Gates, 1995) and the type locality is Naples (Clark and Courtman-Stock, 1976), depth unknown.

Figure 6.98. Distribution of *Amphipholis squamata* in South Africa.

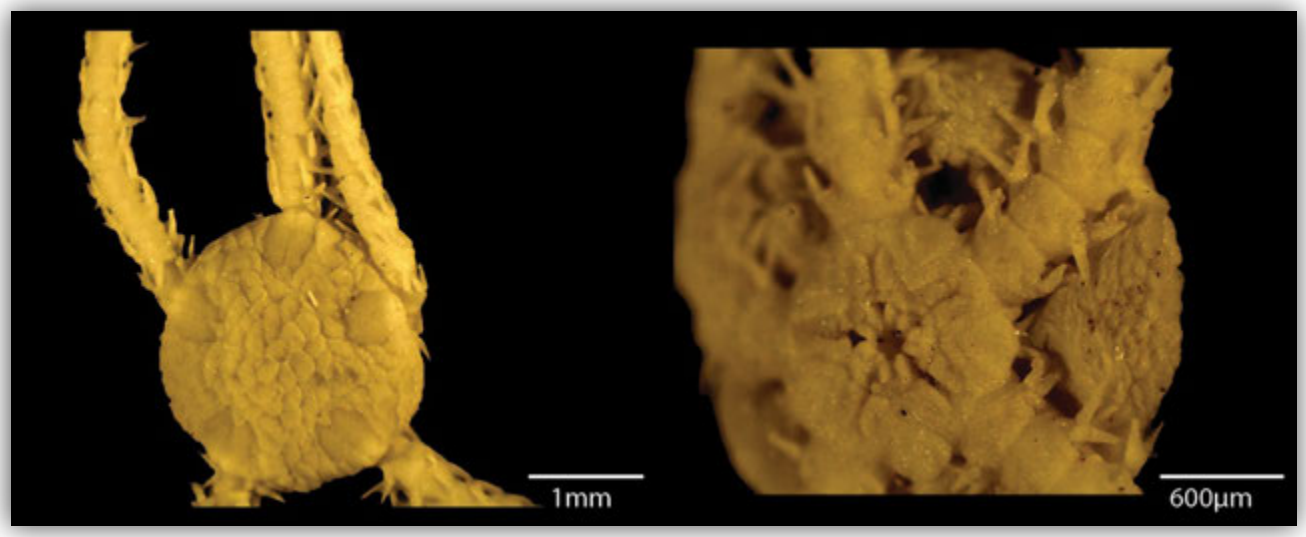

Figure 6.99. Dorsal (left) and ventral (right) views of *Amphipholis squamata* (SAMC A084239).

***Amphipholis strata* Mortensen, 1933**

Figs 6.100 and 6.101.

Amphipholis strata Mortensen, 1933c: 361-363, pl. 19, fig. 20, fig. 68; Clark, 1974: 450-452, fig. 5b-d; Clark and Courtman-Stock, 1976: 103, 117, 152, figs 138, 144, 147.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*

D.D. up to 9mm; D.D./A.L. = 1/3. Primary rosette distinct, scales relatively large, with scales between them. Disc scales large, coarse, polygonal plates. Ventral interradial areas covered in coarse, imbricated scales. Row of 8-9 square scales just below disc margin. Radial shields broad D-shape, fully contiguous, one-third to two-fifths of disc radius. Oral shields diamond-shaped, as long as wide or slightly longer. Adoral shields contiguous. Oral papillae three, in continuous series, outermost very broad and opercular, no oral tentacle scale visible. Genital papillae absent. Dorsal arm plates broad, fan-shape, wider than long, distal margin slightly convex, contiguous. Ventral arm plates fan-shaped, wider than long, distal sides flat or slightly convex, may or may not be narrowly contiguous. Lateral arm plates large. Arm spines three, middle one longest, slightly cigar or club-shaped, may be pointed. Tentacle scales two, fairly large. Disc pale, arms grey (Clark and Courtman-Stock, 1976).

Distribution and habitat

South Africa: off Platbaai (NC) to Port Elizabeth (EC); depth range: 12-349m.
Habitat: Sand, rock, shells, limestone and with polychaete *Phyllochaetopterus* species.

Remarks

Endemic to South Africa (see Table 7.4) and easily distinguished from the other two South African *Amphipholis* species by two main features, i) middle arm spine is longest and cigar-shaped and ii) row of square scales below the disc margin. The syntypes are in the Natural History Museum of Denmark (ZMUC OPH-274 and ZMUC OPH-259) with the type locality being Cape Point, depth 55m. The paratype (SAMC A22378; examined) is located in the SAMC.

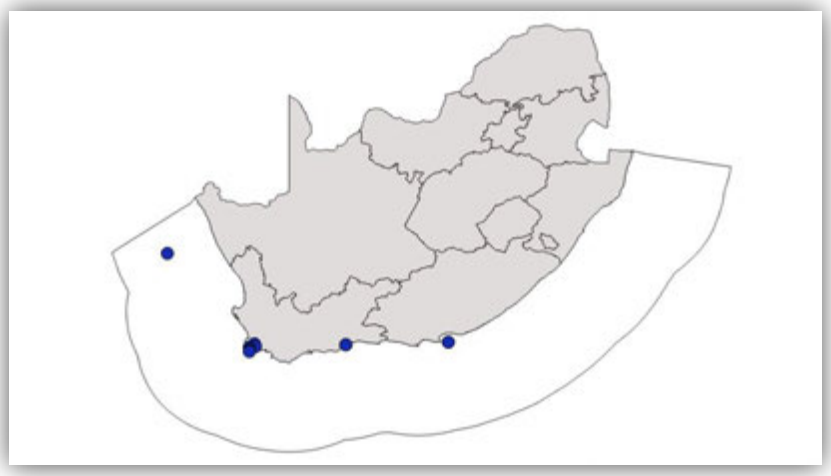

Figure 6.100. Distribution of *Amphipholis strata* in South Africa.

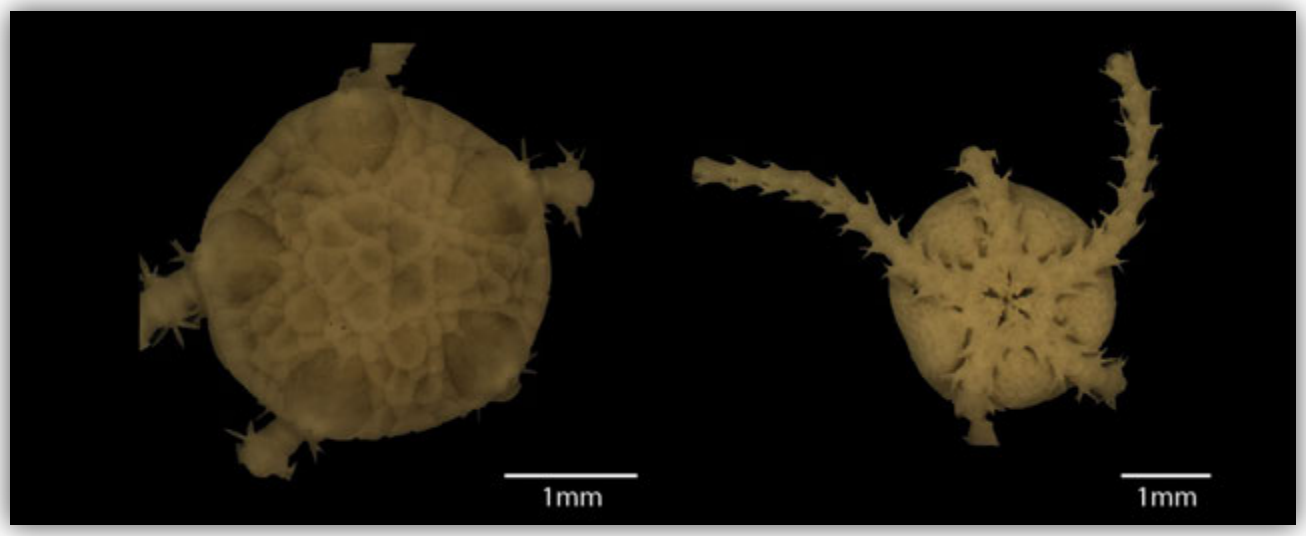

Figure 6.101. Dorsal (left) and ventral (right) views of *Amphipholis strata* (SAMC A073832).

Genus Amphiura Forbes, 1843

Diagnosis *- adapted from Forbes (1843), Matsumoto (1917), Clark (1970) and Clark and Courtman-Stock (1976).*

Disc usually fully-scaled, but without armament. Scaling sometimes reduced on ventral side. Jaws armed with one infradental pair of papillae and one distal oral papilla each side, rarely two arising from the point of contact with the adoral shield. Oral tentacle scale inset in oral slit. Arms moderate or long in length, middle arm spines with specialised tips. Tentacle scales 0-2.

Amphiura (Amphiura) acutisquama A.M. Clark, 1952

Figs 6.102 and 6.103.

Amphiura acutisquama Clark, A.M., 1952: 200, 213-215, fig. 1a, b.
Amphiura (*Amphiura*) *acutisquama*: Clark and Courtman-Stock, 1976: 103, 115, 153, fig. 134.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. 9-15mm, D.D./A.L. = 1/5. Disc indented interradially, disc fully-scaled with small, fine scales, scales slightly larger in vicinity of radial shields and genital slits. Radial shields long and narrow, truncated distally, half disc radius, separated by numerous rows of scales. Ventral interradial area covered in fine scales. Madreporite swollen and circular in outline. Oral shields spearhead-shaped or oval, with lobe on distal side, may be equal or longer than wide. Adoral shields usually not contiguous. Distalmost oral papillae massive, usually with double apex, infradental papillae, elliptical leaf-shaped, sometimes double, ill-defined apex, wide diastema between infradentals and oral papillae. Oral tentacle scale visible between infradental and second oral papillae. Genital slits long, genital papillae absent. Arms moderately long. Dorsal arm plates oval, wider than long, with indistinct rounded distal lobe, not contiguous basally. Ventral arm plates pentagonal, truncated on proximal edge, distally straight or convex on proximal plates, equally long as wide. Arm spines five basally, then three from *c.* segment 13, tapering to a point, as long as or just longer than segment length. Tentacle scales two, moderate in size, tentacle pores on arm large.

Distribution and habitat
South Africa: Zout River (NC) to Port Durnford (KZN); depth range: 340-800m.
Habitat: Sand and mud.

Remarks
Endemic to South Africa (see Table 7.4). Until this study, only a single specimen was known. Four additional specimens were found during this investigation, extending the distribution range from the west coast eastwards to Tinley Manor in KZN and further westwards to the Zout River (see Table 7.3). The type material is presumably in the Natural History Museum (London), but could not be located. The specimen was collected by the *Africana,* station number (AFR798C), but no details other than 'West coast of South Africa' are available.

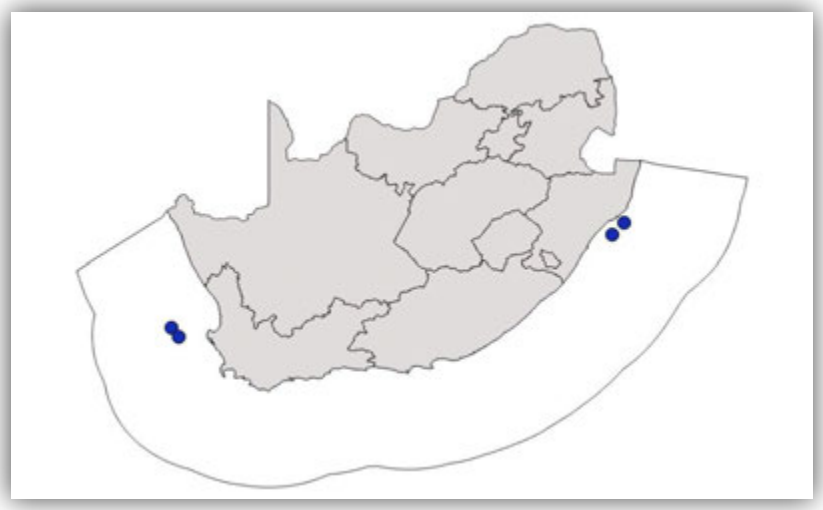

Figure 6.102. Distribution of *Amphiura* (*Amphiura*) *acutisquama* in South Africa.

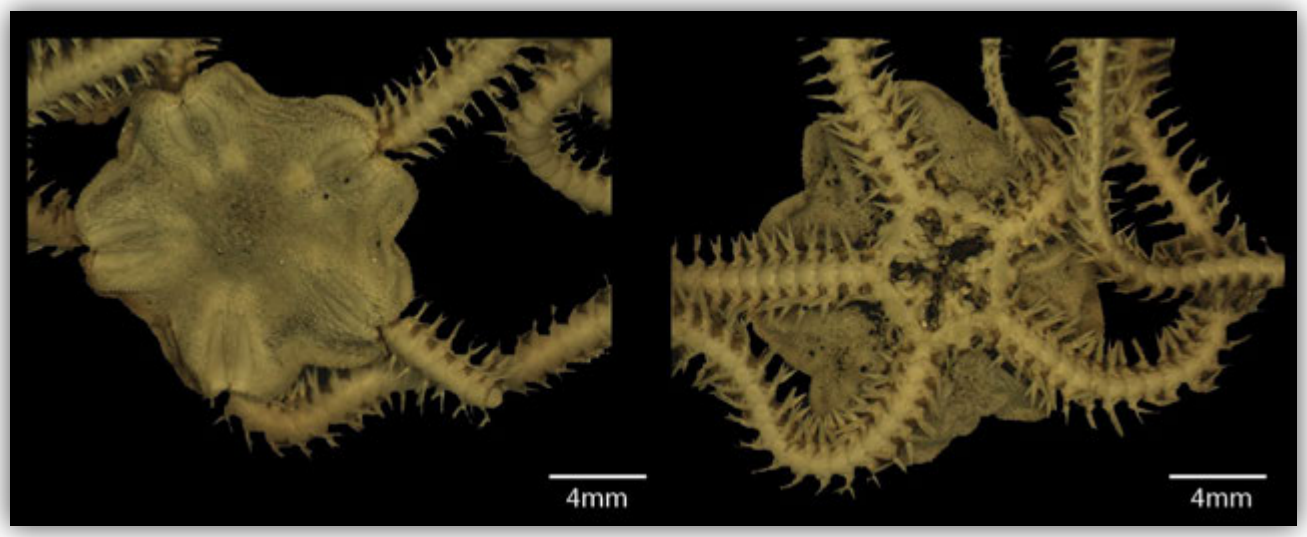

Figure 6.103. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *acutisquama* (SAMC A073830).

Amphiura (Amphiura) albella **Mortensen, 1933**

Figs 6.104 and 6.105.

Amphiura albella Mortensen, 1933c: 359-361, fig. 67a, b; Clark, 1974: 444.
Amphiura (*Amphiura*) *albella*: Clark and Courtman-Stock, 1976: 103, 115, 153, fig. 131.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 6mm, D.D./A.L. = 1/6. Disc indented interradially, disc fully scaled with fine scales. Radial shields long and relatively narrow, separated by single row of scales, *c.* one-third disc radius, approximating distally. Ventral interradial area excavated, naked in proximal areas, then covered in similar scales to dorsal disc. Oral shields vary from spearhead to diamond-shape, may be equal in length and width, or slightly wider. Adoral shields mostly not contiguous. Distal oral papilla one, broad elliptical leaf-shaped, infradental or apical papillae paired, rounded, wide diastema between infradentals and oral papillae. Genital slits long, genital papillae absent. Arms moderately long. Dorsal arm plates broad, fan-shaped with rounded edges, contiguous or barely contiguous proximally, wider than long. Ventral arm plates pentagonal, truncated proximally, as long as wide or slightly longer, broadly contiguous. Lateral arm plates protruding slightly from arm. Arm spines up to five, tapering, proximal ones stout, approximately one segment length. Tentacle scales two proximally, sometimes only one distally.

Distribution and habitat
South Africa: Umgababa (KZN) to Island Rock (KZN); depth range: 411-930m.
Habitat: Soft clay and mud.

Remarks
Endemic to South Africa (see Table 7.4). Distribution range here extended from Amatikulu (KZN) to Island Rock (KZN) (see Table 7.3). The holotype (ZMUC OPH-79) and paratype (ZMUC OPH-361) are in the Natural History Museum of Denmark and the type locality is off Durban, depth 412m.

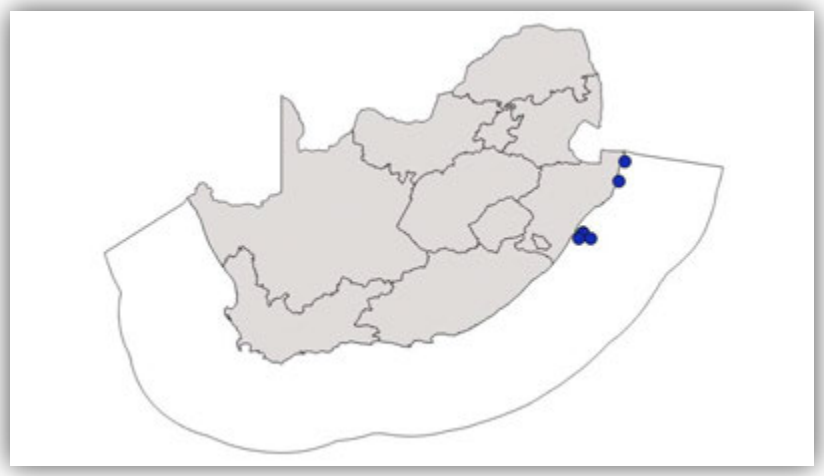

Figure 6.104. Distribution of *Amphiura* (*Amphiura*) *albella* in South Africa.

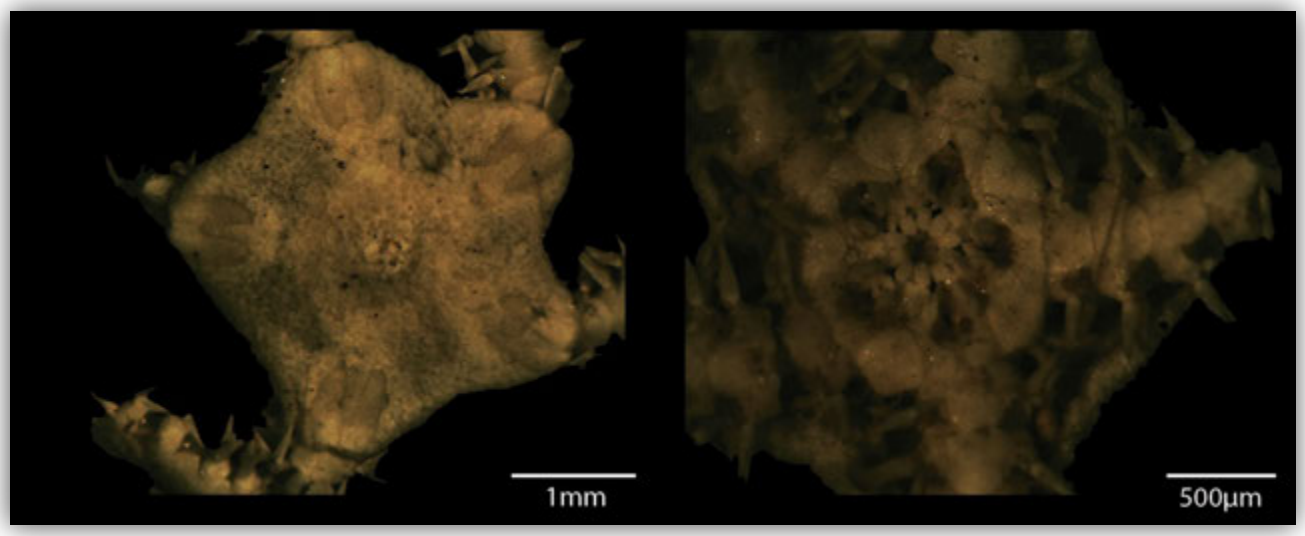

Figure 6.105. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *albella* (SAMC A22938).

***Amphiura (Amphiura) angularis* Lyman, 1879**

Fig. 6.106 and 6.107.

Amphiura angularis Lyman, 1879: 25-26, pl. 11, figs 311-313; Lyman, 1882: 134-135, pl. 29, figs 1-3; Clark, 1923: 327-328; Mortensen, 1933c: 354; Downey, 1969: 21.
Amphiura angularis angularis: Branch *et al.*, 1993: 51.

Diagnosis *- adapted from Lyman (1879).*
D.D. up to 9mm, D.D./A.L. = 1/4. Disc flat, scales indistinct, coarse, overlapping, primary rosette scales slightly larger than other scales. Radial shields short, narrow, longer than wide, tapering distally, separated by two or three rows of irregular scales. Marginal scales continue around outer end of radial shields. One-third ventral interradial areas covered in minute scales, with remaining areas naked. Oral shields large, nearly circular with lobe proximally. Adoral shields not contiguous. Distal oral papillae single, long triangular, tapering, pointed, infradental papillae paired, short, blunt, rounded, wide diastema between infradentals and oral papillae. Arms moderately long. Dorsal arm plates oval, wider than long. First ventral arm plate small and squarish, then nearly square and narrow. Lateral arm plates distinct, sometimes meeting above, but not contiguous ventrally. Arm spines up to five, stout,

blunt, tapering, evenly spaced on lateral arm plate. Tentacle scales one, rounded on inner side of tentacle pore.

Distribution and habitat

Heard Island and Prince Edward Islands (Lyman, 1879; Branch *et al.*, 1993), South Africa: Langebaan (WC) to East London (EC); depth range: 0-348m.
Habitat: Rock and sand.

Remarks

Only specimens from Marion Island were examined from the Iziko South African Museum collection. Clark (1923) and Mortensen (1933c) both reported this species in South Africa, but was not included by Clark and Courtman-Stock (1976) for unknown reasons. Additional records in this study derived from the UCT Ecological Survey collection. The syntypes are in the Museum of Comparative Zoology (MCZ OPH-1286 and MCZ OPH-1375) with the type locality being Heard Island, depth 274m.

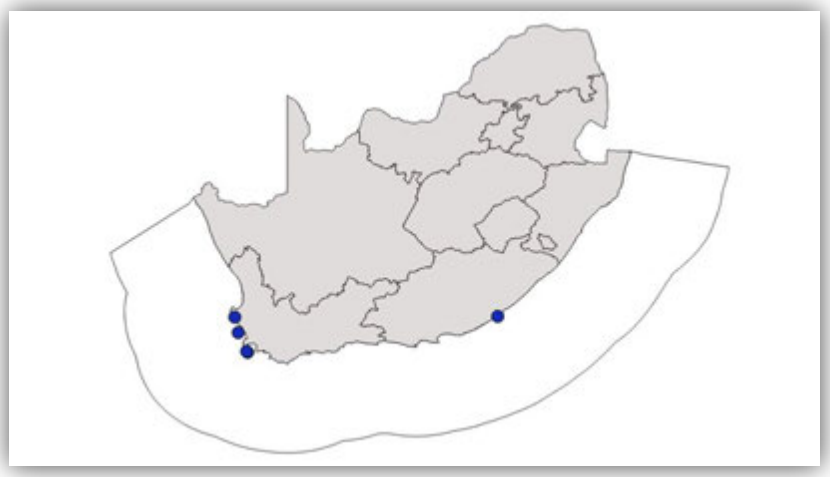

Figure 6.106. Distribution of *Amphiura* (*Amphiura*) *angularis* in South Africa.

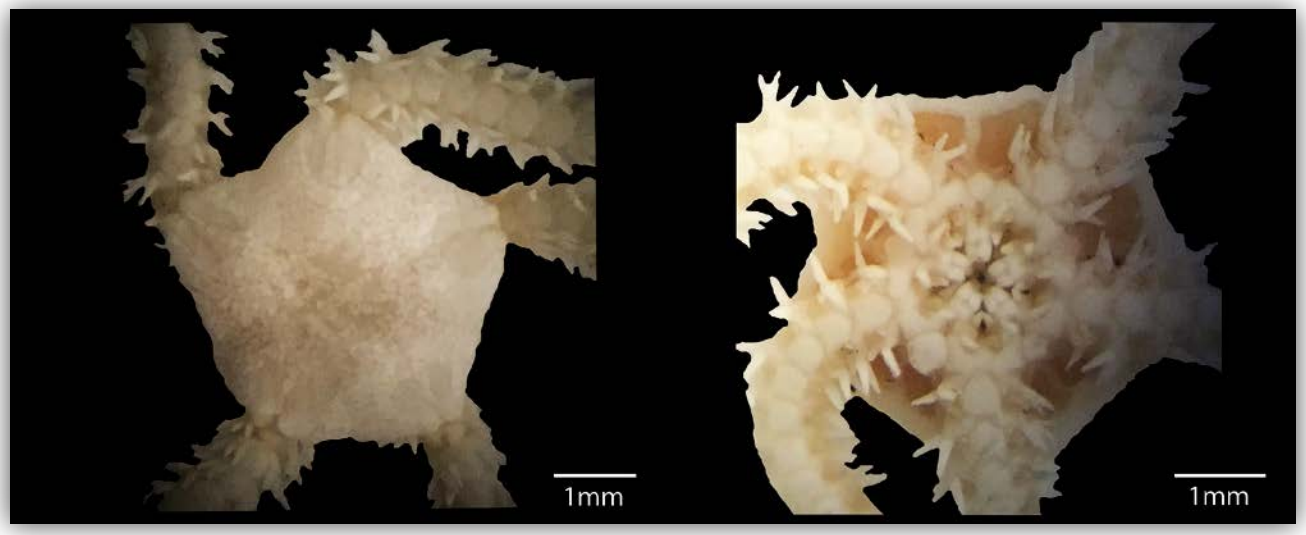

Figure 107. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *angularis* (SAMC A23823).

Amphiura (Amphiura) atlantica Ljungman, 1867

Figs 6.108 and 6.109.

Amphiura atlantica Ljungman, 1867b: 321; Koehler, 1926: 4-6, pl.1, figs 4, 6-9; Mortensen, 1933d: 449-451, figs 17, 18; Madsen, 1970: 181-182, fig. 15; Clark, 1977: 135.
Amphiura dilatata Lyman, 1879: 26, pl. 9, figs 314-316; Lyman, 1882: 135-136, pl. 29, figs 4-6; Clark, 1923: 326-327.
Amphiura (*Amphiura*) *atlantica*: Clark and Courtman-Stock, 1976: 103, 115, 153-154, figs 126, 132.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Madsen (1970).*
D.D. up to 6mm, D.D./A.L. = 1/7. Disc indented interradially, disc fully scaled with fine scales. Primary rosette sometimes distinct. Radial shields long and narrow, wider proximally, separated by usually one elongated scale, less than half disc radius. Ventral interradial area excavated, scales absent, sometimes on disc margin only. Oral shields vary in shape, but usually have proximal lobe which may be flat or rounded and a truncated distal lobe, usually equal in length and width or slightly wider. Adoral shields usually not contiguous, or only just touching. Distal oral papilla one, spiniform, infradental papillae, paired, elliptical leaf-shaped, wide diastema between infradentals and oral papillae. Arms moderately long. Dorsal arm plates fan-shaped with rounded edges, wider than long, not contiguous, usually separated by lateral arm plates, some plates have an indistinct distal lobe. Ventral arm plates square or pentagonal, restricted in middle by tentacle pores, slightly concave on distal side, contiguous. Lateral arm plates distinct. Arm spines up to six, tapering, shorter or equal to segment length, second lowest spine slightly broader at tip with lateral projection, giving it a pick-hammer or axe shape. Genital slits long, genital plates distinct. Tentacle scales rudimentary or absent. Colour in life uniformly orange (Clark and Courtman-Stock, 1976).

Distribution and habitat
St Helena Island, Senegal (Madsen, 1970), South Africa: off Galjoen Bay (NC) to off Durban (KZN); depth range: 30-930m.
Habitat: Sand, mud, shell, silt, rock and among Foraminifera.

Remarks
Distribution range within South Africa here extended from the Northern Cape to KwaZulu-Natal (see Table 7.3). The syntypes are in the Museum of Comparative Zoology (MCZ OPH-1304) (Downey, 1969). The type locality is St Helena Island, South Atlantic Ocean, depth unknown (Ljungman, 1867b).

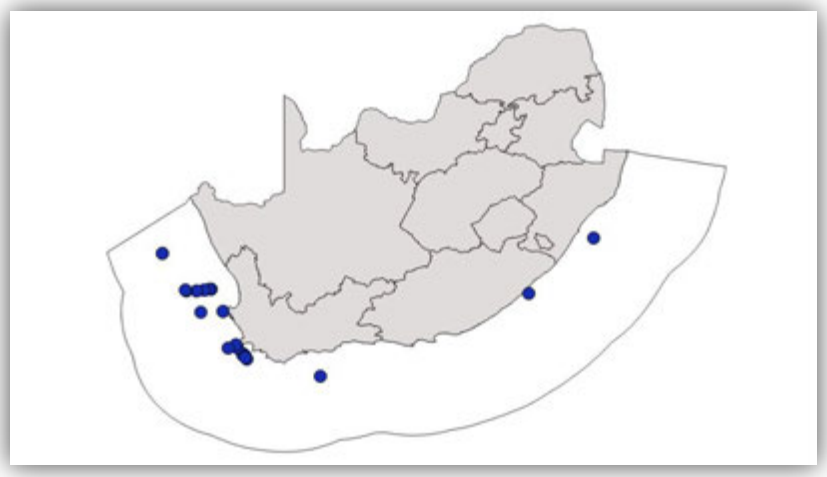

Figure 6.108. Distribution of *Amphiura* (*Amphiura*) *atlantica* in South Africa.

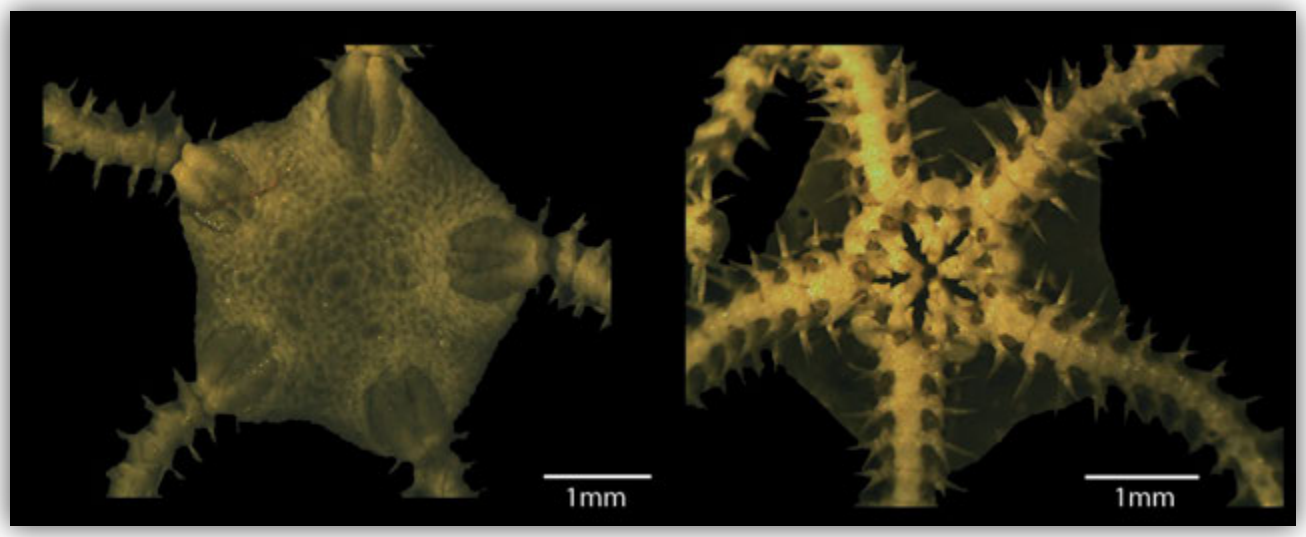

Figure 6.109. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *atlantica* (SAMC A084229).

Amphiura (Amphiura) capensis **Ljungman, 1867**

Figs 6.110 and 6.111.

Amphiura capensis Ljungman, 1867b: 320; Lyman, 1882: 129, pl. 18, figs 14-16; Koehler, 1908a: 634; Döderlein, 1910: 253-254, pl. 5, fig. 2; Koehler, 1914b: 190; Clark, 1923: 327; Mortensen, 1933c: 348-350; Stephenson *et al.*, 1937: 380; Bright, 1937a: 63; Bright, 1937b: 76, 86, 87; Eyre, 1939: 304; Clark, A.M., 1952: 200; Clark, 1955: 18; Day, 1959: 544; Grindley and Kensley, 1966: 13; Day *et al.*, 1970: 81; Clark, 1974: 445-447.
Amphiura adjecta Mortensen, 1933c: 355-357, fig. 62.
Amphiura compressa Mortensen, 1933c: 357-358, figs 63, 64.
Amphiura (*Amphiura*) *capensis*: Clark and Courtman-Stock, 1976: 103, 117, 155, figs 121, 143; Olbers *et al.*, 2014: 15, pl. 2F.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Mortensen (1933c).*
D.D. up to 11mm, D.D./A.L. = 1/5. Disc with moderately coarse scales, primary rosette moderately distinct, ventral interradial areas fully scaled, but sometimes reducing in density proximally and sometimes even naked in patches, scales slightly less coarse than on dorsal surface. Radial shields longer than wide, shorter than half disc radius, diverging and tapering distally, contiguous at distal ends, separated by numerous irregular scales. Oral shields broad spearhead-shaped, equal or longer than wide. Adoral shields not contiguous except in smaller specimens. Distal oral papilla single, short, cone-shaped, flattened, rarely spiniform. Infradental papillae broad with rounded square tips, wide diastema between infradentals and oral papillae. Dorsal arm plates oval to fan-shape, wider than long, contiguous. Ventral arm plates pentagonal or square, truncated, equally or only just wider than long, distal side concave basally. Lateral arm plates distinct, not meeting dorsally or ventrally. Arms moderately long. Arm spines up to seven, upper spines flattened or spatulate and may be axe-shaped at tip. Tentacle scales single, rounded. Colour in life, disc greyish sometimes nearly black, arms yellow or orange, may have dark spots within indistinct bands.

Distribution and habitat
Namibia, Angola, Senegambia (Gambia and Senegal) (Koehler, 1914b; Clark, 1955), South Africa: Orange River (NC) to Sodwana Bay (KZN); depth range: 0-179m.
Habitat: Under stones intertidally, rock, stone, sand, mud, shingle, kelp, associated with patellid molluscs and / or *Gunnarea* (reef-worm) colonies, broken *Lithothamnion.*

Remarks
Distribution extended north east from Amatikulu (KZN) to Kosi Bay (KZN) (see Table 7.3). Types in the Museum of Comparative Zoology (MCZ OPH-1294; MCZ OPH-1286; MCZ OPH-1375) (Downey, 1969) and the Natural History Museum of Denmark with a syntype (as *Amphiura adjecta*) ZMUC OPH-77 (off Durban, depth 64m) and the holotype (as *Amphiura compressa*) ZMUC OPH-78 (False Bay, depth 55m).

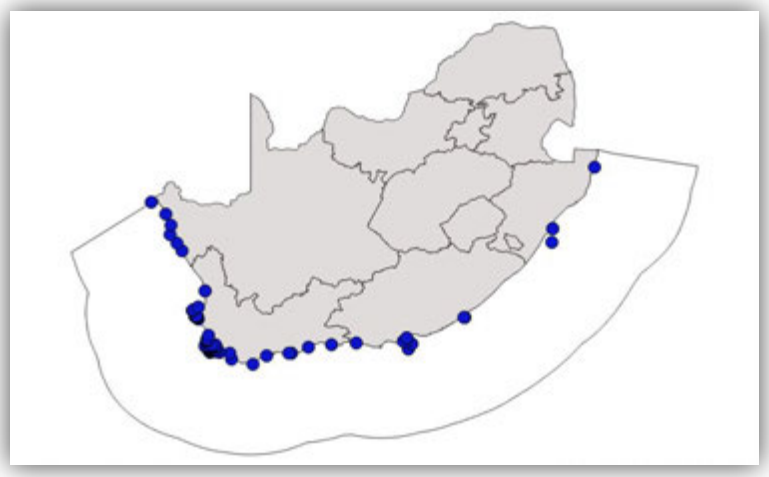

Figure 6.110. Distribution of *Amphiura* (*Amphiura*) *capensis* in South Africa.

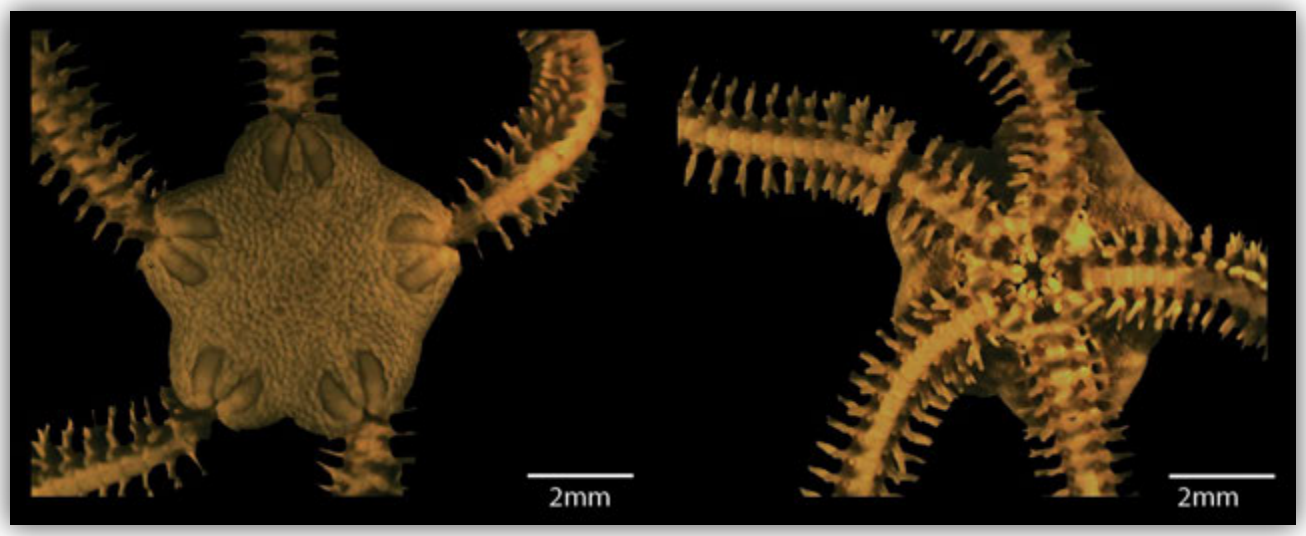

Figure 6.111. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *capensis* (SAMC A084226).

***Amphiura (Amphiura) grandisquama natalensis* Mortensen, 1933**
Figs 6.112 and 6.113.

Amphiura grandisquama natalensis Mortensen, 1933c: 353-354, fig. 60; Clark, 1974: 447-448, fig. 3.
Amphiura (*Amphiura*) *grandisquama natalensis*: Clark and Courtman-Stock, 1976: 103, 115, 155-156, fig. 142.

Diagnosis *- adapted from Clark (1974) and Clark and Courtman-Stock (1976).*
D.D. up to 4mm. Disc fully scaled, scales fine dorsally, ventral interradial scaling slightly finer. Dorsally, primary rosette not distinct. Radial shields moderately long and narrow, converging distally, not

contiguous. Oral shields triangular, rhombic or spearhead-shaped, wider than long. Adoral shields may be only just contiguous, or not at all. Distal oral papillae single, small, moderate in size. Infradental papillae paired, blunt and elliptical leaf-shaped, wide diastema between infradentals and oral papillae. Dorsal arm plates fan-shaped, slightly rounded, becoming pointed distally. Ventral arm plates truncated pentagonal with distal lobe. Arm spines up to five, pointed, tapering, one segment length, lowest spine longer, up to three times segment length, may be clavate or slightly curved. Tentacle scale single, large, round, covering pore.

Distribution and habitat

South Africa: Durban (KZN) to Black Rock (KZN); depth range: 225-825m.
Habitat: Green sand and mud.

Remarks

Endemic to South Africa (see Table 7.4), distribution range here extended from Durban to Black Rock in KZN (see Table 7.3). The paratype (SAMC A22365; examined) is in Iziko South African Museum and a syntype in the Natural History Museum of Denmark (ZMUC OPH-210). The type locality is off Durban, depth 411m.

Figure 6.112. Distribution of *Amphiura* (*Amphiura*) *grandisquama natalensis* in South Africa.

Figure 6.113. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *grandisquama natalensis* (ZMUC OPH-210).

Amphiura (Amphiura) incana Lyman, 1879

Figs 6.114 and 6.115.

Amphiura incana Lyman, 1879: 20, pl. 11, figs 285-287; Lyman, 1882: 128, pl. 33, figs 5-7, pl. 46, fig. 5; Clark, 1923: 328-329; Hertz, 1927b: 34, pl. 7, fig. 1; Mortensen, 1933c: 351, fig. 60c; Mortensen, 1936: 286-287; Clark, A.M., 1952: 200; Morgans, 1959: 308-310, 312, 313, 315, 322; Downey, 1969: 29; Day *et al.*, 1970: 81; Madsen, 1970: 173-177, figs 8-10.
Amphiura atlantica var*. dilatata* Mortensen, 1933c: 351-353, figs 59, 60b; Clark, A.M., 1952: 200; Day *et al.*, 1970: 81.
Amphiura sculpta Clark, 1955: 19, 26, 47-48, fig. 22.
Amphiura (*Amphiura*) *incana*: Clark and Courtman-Stock, 1976: 103, 156.

Diagnosis *- adapted from Lyman (1879) and Clark and Courtman-Stock (1976).*
D.D. up to 9mm, D.D./A.L. = 1/7. Disc with tumid, coarse scales, primary rosette moderately distinct, ventral interradial areas fully scaled with fine scales. Radial shields short to moderately long, narrow, *c.* one-quarter to one-third disc radius, tapering distally, separated by two or three rows of irregular scales with marginal scales continuing around outer end of radial shields. Oral shields vary in shape, spearhead-shaped, pentagonal, nearly circular or rhombic, may be sunken centrally, as long as wide or wider. Adoral shields just contiguous or not. Distal oral papillae single, short, very broad. Infradental papillae paired, broad, pointed, wide diastema between infradentals and oral papillae. Arms moderately long. Dorsal arm plates rounded to square in shape, slightly wider than long. Ventral arm plates squarish to pentagonal, with distal edge concave. Lateral arm plates thick but not prominent, not meeting dorsally or ventrally. Arm spines up to eight, short, thick, blunt, flattened and shorter than segment length. Tentacle scales two, rounded, moderate to small in size. Colour in life, disc grey, arms with pink, orange or red longitudinal stripe (Clark and Courtman-Stock, 1976).

Distribution and habitat
North Atlantic Ocean, West Africa, west Mediterranean (Madsen, 1970), South Africa: Lambert's Bay (WC) to Tugela River (KZN); depth range: 7-300m.
Habitat: Sand, rock, mud, shell, shingle, limestone and broken *Lithothamnion.*

Remarks
Distribution range extended here from Durban (KZN) to Tugela River mouth (KZN) (see Table 7.3). The distinguishing features of *Amphiura* (*Amphiura*) *incana* include the arm spines, which are short, thick and up to eight. The type material is in the Museum of Comparative Zoology (syntypes: MCZ OPH-1323 and MCZ OPH-1389) and the type locality is Simon's Bay, depth 18-36m.

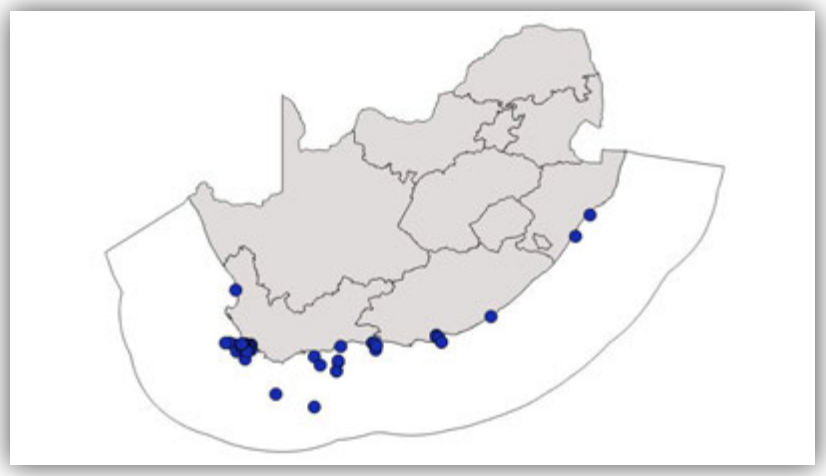

Figure 6.114. Distribution of *Amphiura* (*Amphiura*) *incana* in South Africa.

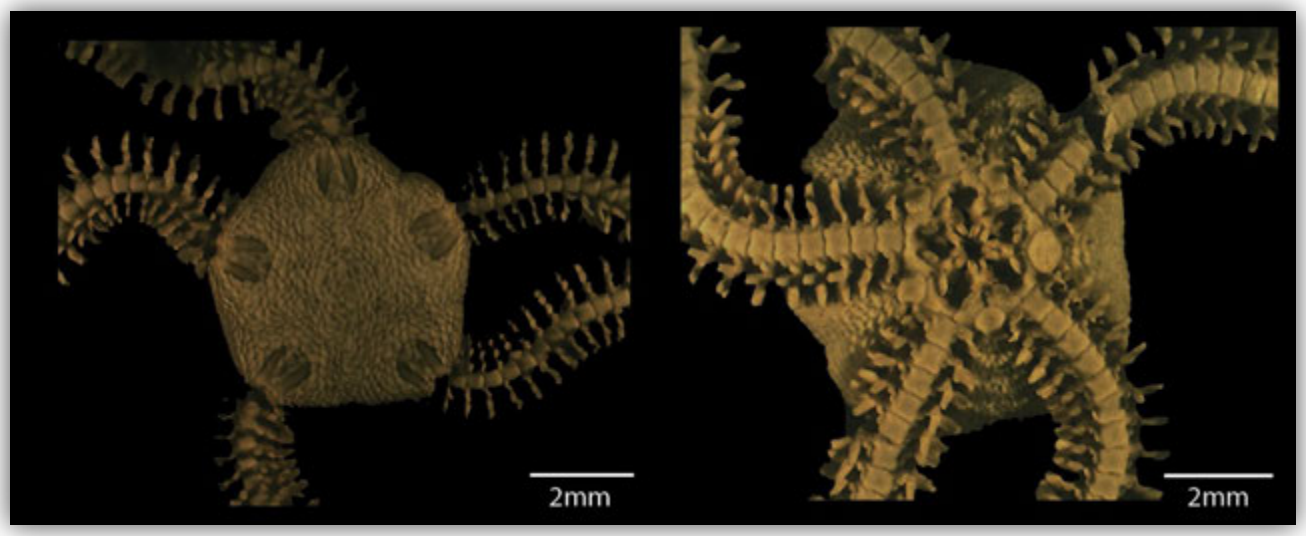

Figure 6.115. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *incana* (SAMC A23378).

***Amphiura (Amphiura) linearis* Mortensen, 1933**

Figs 6.116 and 6.117.

Amphiura linearis Mortensen, 1933c: 354-355, fig. 61; Clark, 1974: 475.
Amphiura (*Amphiura*) *linearis*: Clark and Courtman-Stock, 1976: 103, 115, 157, fig. 141.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Clark (1974).*
D.D. up to 3.5mm, D.D./A.L. = 1/5. Disc with small fine scales both dorsally and ventrally. Radial shields narrow, linear or nearly parallel, more than one-third disc radius, not tapering, well-separated. Oral shields broad spearhead-shaped with rounded proximal lobe, as wide as long. Adoral shields triangular, just contiguous. Distal oral papilla single, pointed. Infradental papillae paired, pointed, wide diastema between infradentals and oral papillae. Arms moderately long. Dorsal arm plates narrow, fan-shape, longer than wide. Ventral arm plates narrow, pentagonal, truncated or rounded distal edge. Arm spines up to six, slightly flattened, tapering, pointed, lowermost longest, exceeding segment length. Tentacle scales single, moderately large, slightly elongated, triangular or cone-shaped.

Distribution and habitat
South Africa: Amanzimtoti (KZN) to Durban (KZN); depth range: 91- 165m.
Habitat: No information available.

Remarks
Endemic to South Africa (see Table 7.4). There are only two damaged specimens known, presumably the two in the Natural History Museum of Denmark. Both Clark (1974) and Clark and Courtman-Stock (1976) mentioned that the type material is damaged and should be re-examined and compared to *Ophiopsila bispinosa,* which has similar radial shields and arm spines. The type material is in the Natural History Museum of Denmark (syntypes: ZMUC OPH-190 and ZMUC OPH-360) with the type locality off Durban, depth 91-165m.

Figure 6.116. Distribution of *Amphiura* (*Amphiura*) *linearis* in South Africa.

Figure 6.117. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *linearis* (ZMUC OPH-190).

***Amphiura (Amphiura) otteri* Ljungman, 1872**

Figs 6.118 and 6.119.

Amphiura otteri Ljungman, 1872: 631-632; Lyman, 1879: 32; Lyman, 1882: 128; Lyman, 1883: 252; Koehler, 1907: 302, pl. 11, fig. 19; Koehler, 1914a: 61, pl. 8, figs 5-9; Mortensen, 1927: 210; Paterson, 1985: 86-87, fig. 33.
Amphiura grandis Koehler, 1896a: 246-247; Koehler, 1907: 301; Koehler, 1909b: 175-177; pl. 27, figs 3, 4; Mortensen, 1927: 210.

Diagnosis *- adapted from Paterson (1985).*
D.D. up to 11mm. Disc pentagonal, indented interradially, with moderate coarse scales, primary rosette distinct, ventral interradial areas fully scaled with fine scales. Radial shields moderately long, about half disc radius, converging distally and touching on distal ends. Oral shields spearhead-shaped, longer than wide. Adoral shields not contiguous. Distal oral papillae one, spiniform, arising from adoral shields. Infradental papillae paired, elliptical leaf-shaped, often contiguous, wide diastema between infradentals and oral papillae. Dorsal arm plates oval or hexagonal, wider than long, proximal plates almost contiguous. Ventral arm plates pentagonal, becoming squarish distally, contiguous, may have

slight concave notch on distal side. Tentacle pores large. Arm spines up to eight, pointed, some with terminal hook. Tentacle scales two, small in size, may be missing on some segments.

Distribution and habitat

North Atlantic (West Indies to Cape Verde), Gulf of Mexico, Caribbean, British Isles (Paterson, 1985), South Africa: off Cape Town (WC) to Port Elizabeth (EC); depth range: 198-3200m.
Habitat: No information available.

Remarks

Two specimens (SAMC A22102 and SAMC A22100; examined) were determined by A.M. Clark after 1959, but they were badly damaged. The identification could not be confirmed or disputed, possibly a reason why this species was not included by Clark and Courtman-Stock (1976). This species remains as part of the South African fauna, but is considered dubious. The syntypes are in the Swedish Museum of Natural History (SMNH-Type-1412) and the type locality is off Portugal, depth 1001m.

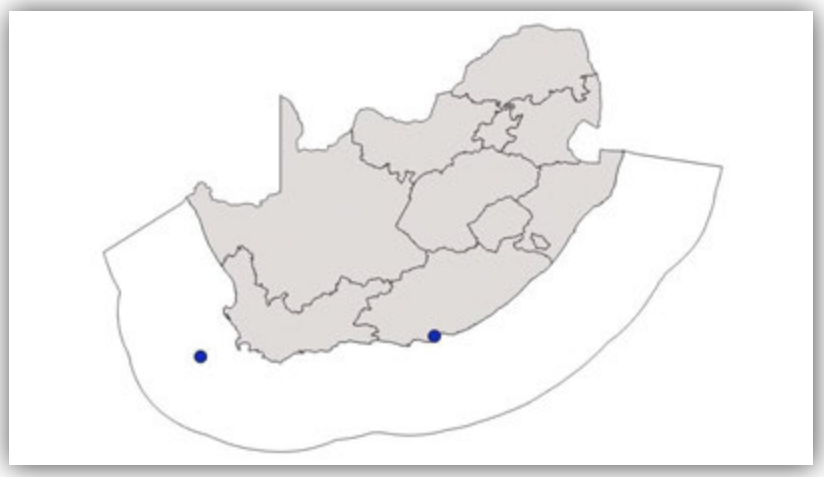

Figure 6.118. Distribution of *Amphiura* (*Amphiura*) *otteri* in South Africa.

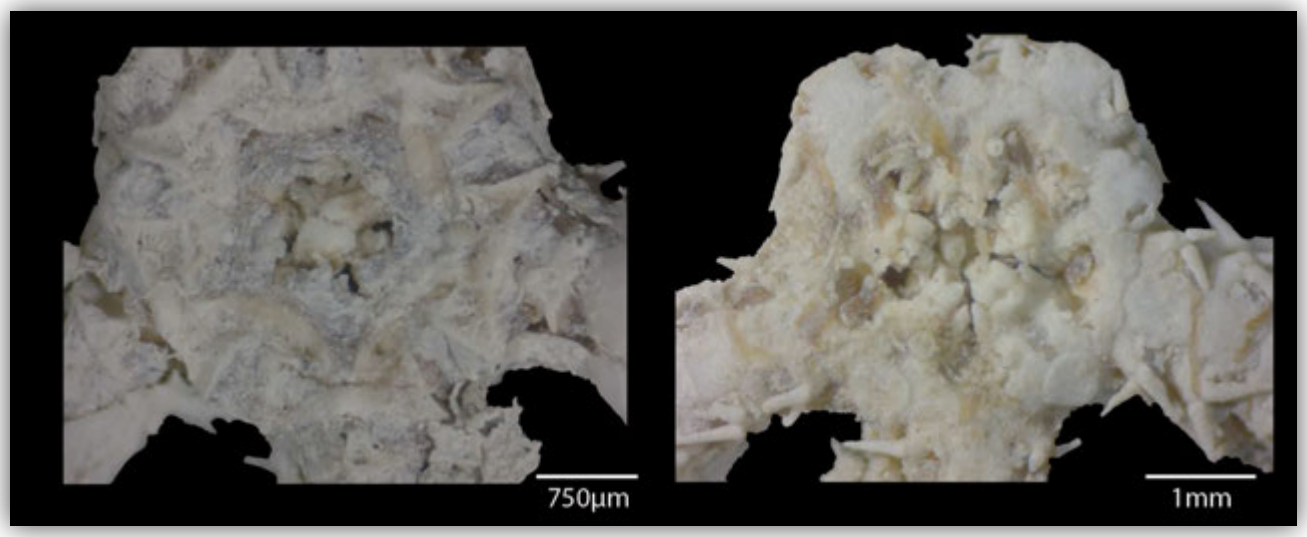

Figure 6.119. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *otteri* (SAMC A22100).

Amphiura (Amphiura) simonsi A.M. Clark, 1952

Figs 6.120 and 6.121.

Amphiura simonsi Clark, A.M., 1952: 215-217, fig. 2; Morgans, 1959: 322; Clark, 1974: 448-449, fig. 4.
Amphiura (*Amphiura*) *simonsi*: Clark and Courtman-Stock, 1976: 103, 115, 157, figs 129, 133.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Clark (1974).*

D.D. = 6-7mm, D.D./A.L. = 1/9. Dorsal disc with small, coarse, delicate and thin scales, ventral interradial areas lacking scales, but these easily rubbed off. Primary rosette not distinct. Radial shields relatively small, contiguous distally and diverge proximally, less than one-third of disc radius. Oral shields small, vary in shape, oval or broad triangular. Adoral shields large, with broad distal lobe between oral shield and first lateral arm plate, contiguous. Distal oral papillae two[7], one short and conical, the other more rounded or blunt. Infradental papillae paired, broad, blunt, wide diastema between infradentals and oral papillae. Arms long. Dorsal arm plates fan-shaped, wider than long, rudimentary on basal segments exposing underlying structure. Ventral arm plates square to rectangular, distal edge slightly concave. Arm spines up to five, as long as segment length, spines flattened and paddle-shaped, second lowest spine conspicuously curved, hook-shaped sometimes with hyaline hooks, lowest spine flattened or cylindrical but tapering. Tentacle scale one, small, usually absent in basal pores. Colour in life, arms pale orange and banded (Clark and Courtman-Stock, 1976).

Distribution and habitat

South Africa: Cape Town (WC) to Mtunzini (KZN); depth range: 0-110m.
Habitat: Sand, shell, shingle, gravel, mud and rock.

Remarks

Endemic to South Africa (see Table 7.4). The type material in Iziko South African Museum (SAMC A23228; examined) is labelled as a ‘cotype’. The type locality is Gordon’s Bay, depth 36m.

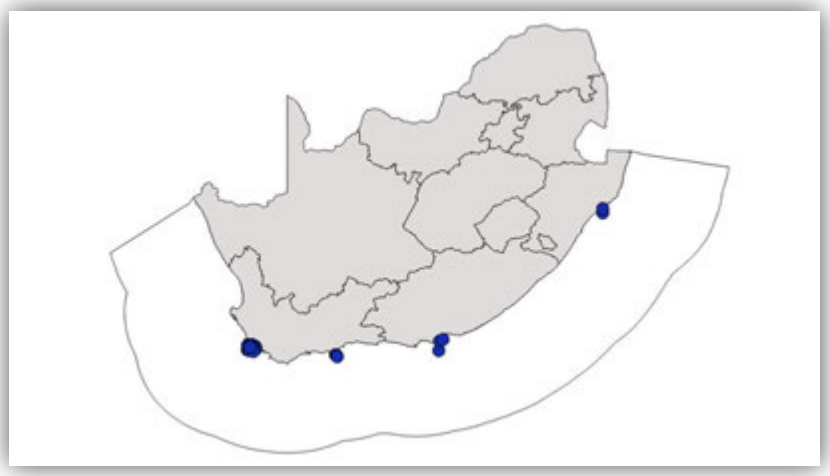

Figure 6.120. Distribution of *Amphiura* (*Amphiura*) *simonsi* in South Africa.

[7] Both Clark (1974) and Clark and Courtman-Stock, 1976 noted that the outer papilla may not be a true papilla but rather a calcified extension of the rim of the second oral tentacle pore.

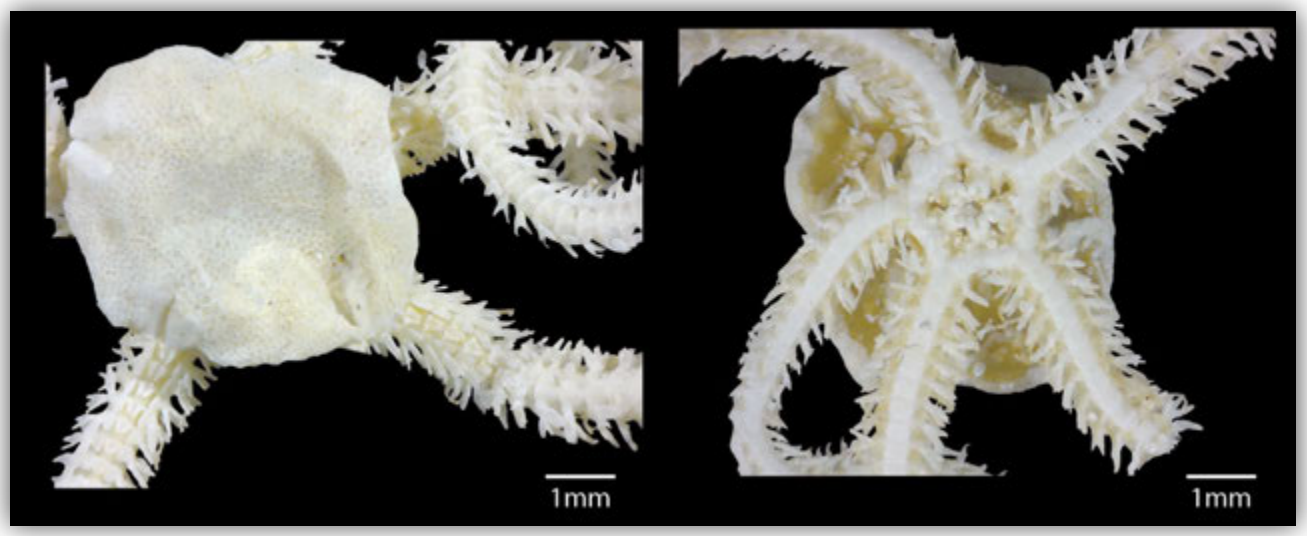

Figure 6.121. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *simonsi* (SAMC A084236).

Amphiura (Amphiura) uncinata **Koehler, 1904**

Figs 6.122 and 6.123.

Amphiura uncinata Koehler, 1904a: 76-77, pl. 14, figs 3, 4; Koehler, 1922b: 160, pl. 65, fig. 6-8, pl. 96, fig. 4; Mortensen, 1933c: 358-359, figs 65, 66; Clark, H.L., 1939: 58.
Amphiura (*Amphiura*) *uncinata*: Clark and Courtman-Stock, 1976: 103, 115, 158, fig. 125.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 11mm, D.D./A.L. = 1/10. Dorsal disc with moderately large, coarse scales, primary rosette distinct with scales in between. Ventral interradial area scaled distally with scattered scales proximally. Radial shields large, long and narrow, more than half disc radius, tapering proximally, separated by rows of irregular scales, approximating distally. Oral shields spearhead-shaped to triangular, longer than wide. Adoral shields contiguous, triangular. Distal oral papilla single, short, broad, semi-circular or conical. Infradental papillae paired, moderately broad, pointed, wide diastema between infradentals and oral papillae. Arms long. Dorsal arm plates broad fan-shaped with rounded distal edge, wider than long, contiguous. Ventral arm plates pentagonal to almost fan-shaped, narrowly contiguous. Arm spines up to six basally, pointed, middle spines hyaline and curved with hooked tip, distally some spines not curved. Tentacle scales two, moderate in size.

Distribution and habitat
Zanzibar, South Arabian Coast, East indies, Java, Philippines, Kei Islands (Clark, H.L., 1939), South Africa: Durban (KZN) to Umhlanga (KZN); depth range: 100-1415m.
Habitat: Sandy and green mud.

Remarks
Type material whereabouts unknown, type locality is East of Java, East Indies, depth 250-350m.

Figure 6.122. Distribution of *Amphiura* (*Amphiura*) *uncinata* in South Africa.

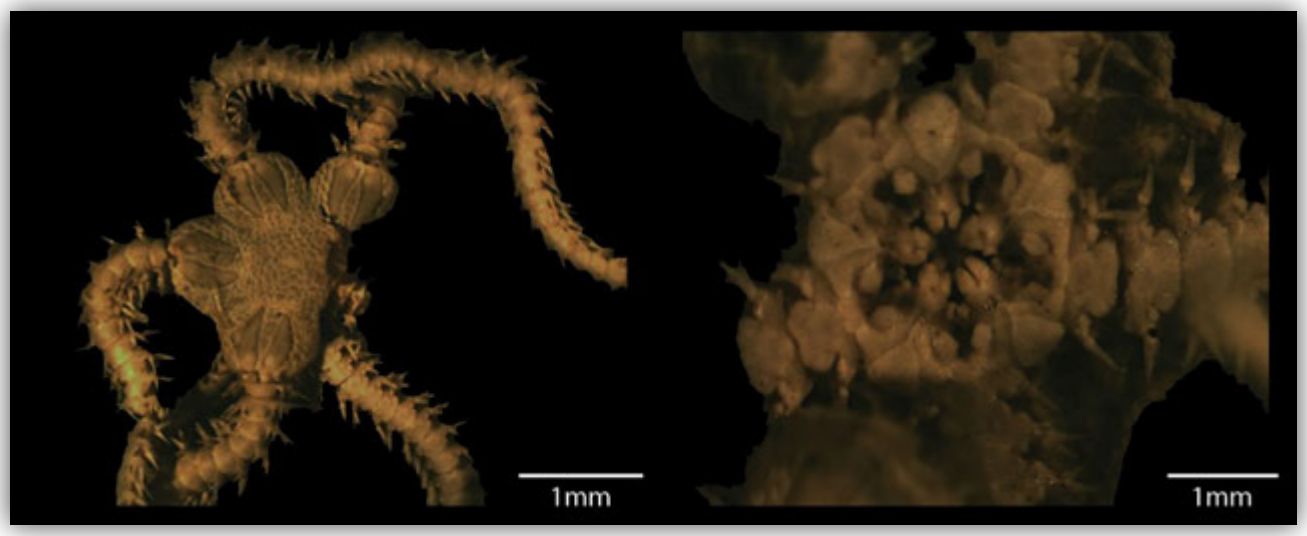

Figure 6.123. Dorsal (left) and ventral (right) views of *Amphiura* (*Amphiura*) *uncinata* (SAMC A23229).

Genus *Ophiodaphne* Koehler, 1930

Diagnosis - *adapted from Parameswaran et al. (2013).*

A sexually dimorphic genus, male dwarfed and attached to larger female mouth-to-mouth with alternating arms. The female oral structure is indented to accommodate the smaller male. Infradental papillae paired. Oral papillae fused, sometimes forming a serrated flange. Oral shields smaller than adoral shields.

Ophiodaphne scripta (Koehler, 1904)

Figs 6.124 and 6.125.

Amphiura scripta Koehler, 1904b: 70-71, figs 23, 24.
Amphilycus androphorus Mortensen, 1933a: 185-188, figs 4-6; Tortonese, 1936: 221; Balinsky, 1957: 11; Macnae and Kalk, 1962: 115, 118; Balinsky, 1969: 99, 106, 129.
Amphilycus scripta: Clark, 1967: 41, fig. 2a, c; Clark and Rowe, 1971: 103, fig. 32a, c; Clark and Courtman-Stock, 1976: 102, 114, 147, fig. 124; Vine, 1986: 195; Liao and Clark, 1995: 182, fig. 82.
Ophiodaphne scripta: Cherbonnier and Guille, 1978: 128-130, fig. 58; Parameswaran *et al.*, 2013: 333-339, figs 1, 2, 4.

Diagnosis *- adapted from Cherbonnier and Guille (1978) and Parameswaran et al. (2013)***.**
D.D. up to 4mm (female), up to 1mm (male). Sexually dimorphic, male dwarfed, attached to underside of female. Female with distinct grooves on ventral side with the whole jaw structure indented. Disc round to pentagonal, dorsal disc scales moderately coarse, primary rosette moderately distinguishable, centre plate present and conspicuous, rows of slightly larger dorsal disc scales in interradial areas, matching where male places his arms, these scales approximately same size as primary rosette scales. Radial shields naked, D-Shaped, moderate in size, just less than half disc radius, contiguous for entire length except proximal-most parts, where small triangular disc scale present. Ventral interradial areas scaled and unarmed. Oral shields diamond-shaped, small. Adoral shields large, contiguous. Infradental papillae more or less symmetrical. Oral papillae none, but long, continuous, serrated flange along oral plate. Genital slits reach disc margin, genital papillae absent. Dorsal arm plates elliptical, with slight lobe distally, narrowly contiguous. Lateral arm plates almost touching dorsally. Ventral arm plates square, very slight distal notch, contiguous. Arm spines five, cylindrical, tapering, slightly longer than segment length, but may be up to twice segment length, some with double or triple hooks at their bases directed proximally. Tentacle scale one, large. Male: identical to female except smaller in size, dorsal disc with primary rosette of five scales and central plate, no indentation of jaws and dorsal arm plates fan-shaped. Colour in life, disc grey or pale lavender-blue, distal edges of radial shields white, arm plates variegated with purple-red, grey and white, arm spines glassy or colourless (Clark, 1938).

Distribution and habitat
Mozambique, Madagascar, Red Sea, Persian Gulf and India (Mortensen, 1933a; Cherbonnier and Guille, 1978; Parameswaran *et al.*, 2013), South Africa: Sodwana Bay (KZN) to Kosi Bay (KZN); depth range: 0-78m.
Habitat: Sand, found on the underside of the cake urchins *Echinodiscus auritus* and *E. bisperforatus*.

Remarks
The southern-most record for southern Africa from Clark and Courtman-Stock (1976) was the degree square (26/33) which overlaps the border between South Africa and Mozambique and perhaps represents the first record for South Africa. However, the two specimens examined during this study, were collected in 1999 together with their dwarfed males from Sodwana Bay and are now housed at Royal Museum for Central Africa in Belgium. The type material was assumed to be in the National Natural History Museum in Paris (MNHN) but it was not located, type locality is Oman.

Figure 6.124. Distribution of *Ophiodaphne scripta* in South Africa.

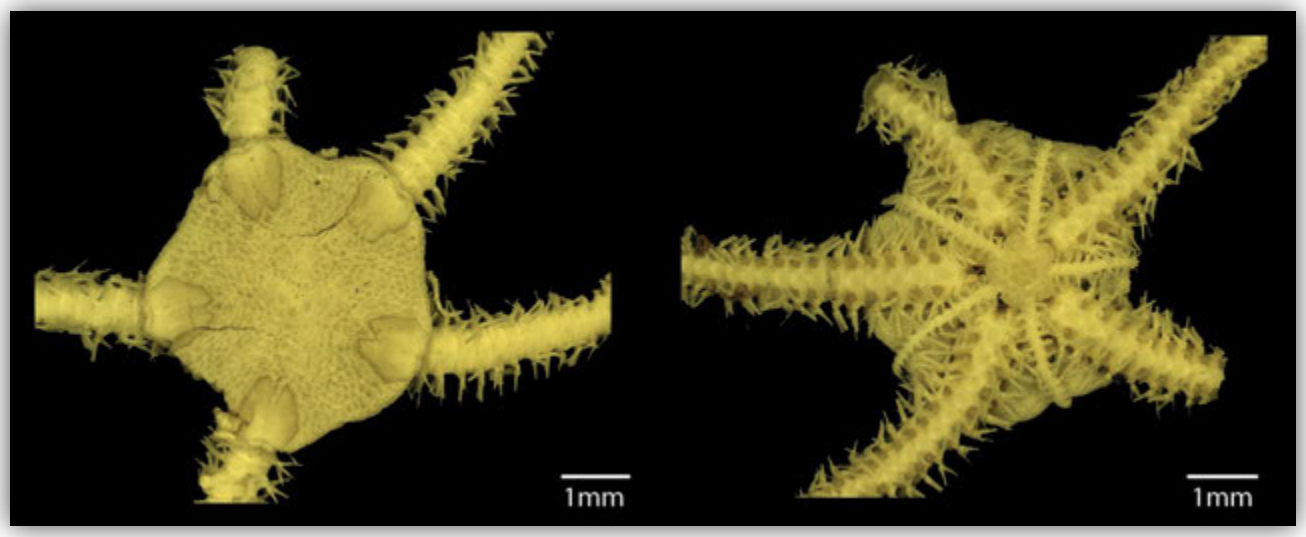

Figure 6.125. Dorsal (left) and ventral (right) views of *Ophiodaphne scripta*, together with dwarf male attached (RMCA MT2311).

Genus Ophionephthys Lütken, 1869

Diagnosis - *adapted from Lyman (1882) and Lütken (1869).*
Disc small and naked except at radial shields and on margin. Arms long, slender. Oral papillae 2-6. Arm spines 4-5, small. Genital slits two, small.

Ophionephthys lowelli Clark, 1974

Figs 6.126 and 6.127.

Ophionephthys lowelli Clark, 1974: 462-464, fig. 10a-e; Clark and Courtman-Stock, 1976: 103, 116-117, 159-160; Mbongwa, 2013: 15; Olbers *et al.*, 2015: 93, pl. 3A, B.

Diagnosis - *adapted from Clark (1974) and Clark and Courtman-Stock (1976).*
D.D. up to 8mm, D.D./ A.L. = 1/10. Disc round, in all specimens on hand, dorsal disc 'lid' missing. Oral shields variable, as wide or wider than long, triangular with broadly rounded angles, widest proximally or rhombic with proximal lobe flattened. Adoral shields triangular, widely separated interradially, with broad distal lobe contiguous with lateral arm shield. Jaws slightly sunken, with two large, broad infradental oral papillae, appearing in preserved specimens to be apical papillae. Two spiniform, rugose-tipped oral papillae, one shorter than the other and both attached to oral plate and in series with infradental papillae. Oral tentacle scale distinct, short and sharp, situated close to teeth. No genital papillae, genital slits small and indistinct. Arms long, first 7-9 dorsal arm plates rudimentary, showing underlying structure, plates becoming whole, square or slightly longer than wide, with rounded edges slightly convex on distal side and concave on proximal side, broadly contiguous. Ventral arm plates identical in shape, convex distally, overlapping each other, longer than wide. Arm spines 4-5, lowest one thick, blunt, approximately segment length, remaining spines slightly shorter and tapering but blunt, covering not smooth, slightly rough. Tentacle scale single, oval, longer than wide, *c.* half segment length.

Distribution and habitat
South Africa: East London (EC) to Sodwana Bay (KZN); depth range: 0-55m.
Habitat: Found in brown sand, shell, mud and coral sand.

Remarks
Endemic to South Africa (see Table 7.4). Olbers *et al.* (2015) suggested that a neotype be designated, as the holotype had disintegrated in the jar. The type material is in Iziko South African Museum (holotype: SAMC A22782; paratype: SAMC A22781; examined). Type locality East London, depth 51m.

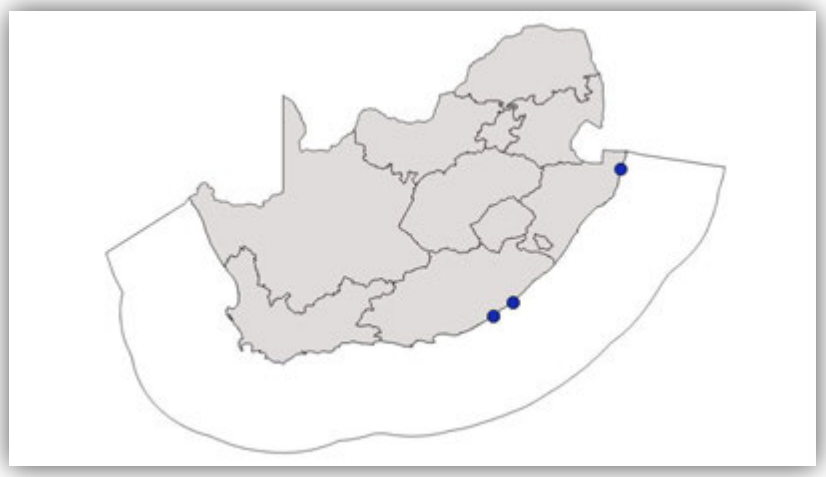

Figure 6.126. Distribution of *Ophionephthys lowelli* in South Africa.

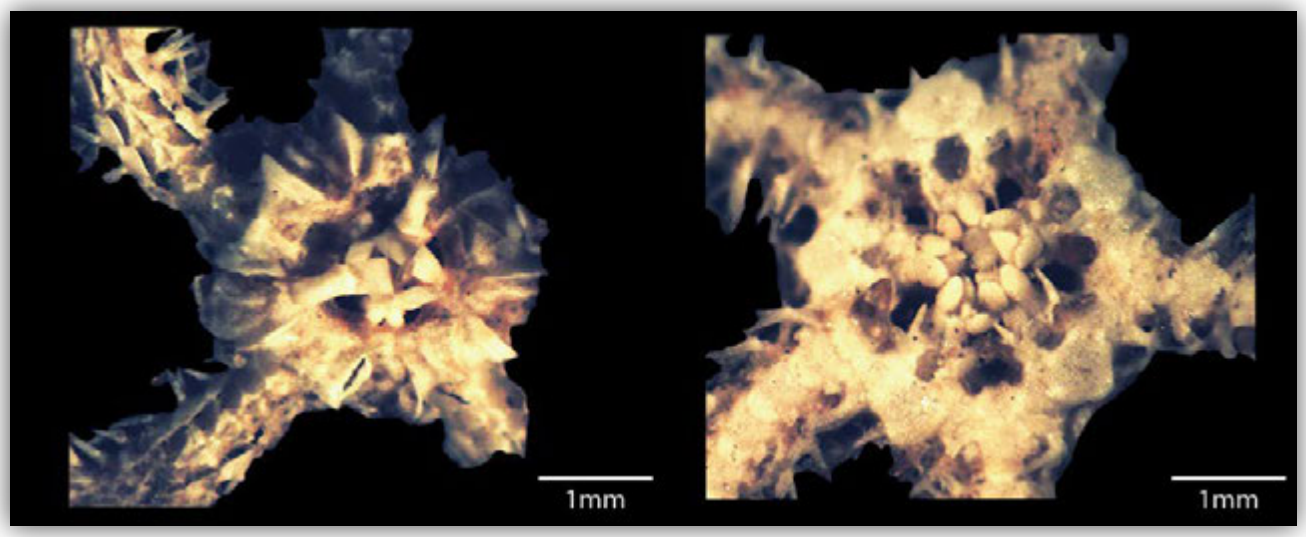

Figure 6.127. Dorsal (left) and ventral (right) views of *Ophionephthys lowelli* (SAMC A22781).

Family OPHIACTIDAE Matsumoto, 1915

Diagnosis *- adapted from Matsumoto (1915), Spencer and Wright (1966), Mortensen (1927), Clark and Courtman-Stock (1976).*
Disc scaling well-developed, primary rosette often distinct. Scales with scattered spinelets, granules or spines. Radial shields triangular, contiguous or approximating distally, small. Jaws with apical series of broad rounded or rectangular teeth and single broad, blunt oral papilla, may be absent, separated by a gap in which an oral tentacle scale can be seen. Distal oral papillae 1-2 each side. Arms slender or moderately stout, six arms in fissiparous species. Arm spines stout, erect, opaque, may be superficially smooth and tapering or rugose and blunt. Tentacle scales usually one, large and rounded.

Genus Histampica A.M. Clark, 1970

Diagnosis *- adapted from Clark (1970).*

Disc covered with overlapping scales, armament absent. Radial shields moderately large. Oral papillae 4-5 on either side of each jaw, unequal in size, arranged almost in a continuous series. Teeth triangular, with pointed ends. Dental papillae absent. Oral shields large. Adoral shields long and slender. Tentacle scales two.

Histampica duplicata (Lyman, 1875)

Figs 6.128 and 6.129.

Amphiura duplicata Lyman, 1875: 19-20, fig. 87, pl. 5, fig. 78; Lyman, 1882: 136, pl. 17, figs 10-12; Lyman, 1879: 31-32; Koehler, 1896a: 244; Koehler, 1896b: 208.
Amphiura partita Koehler, 1897, 336-337, pl. 7, figs 50, 51.
Ophiactis duplicata: Lütken and Mortensen, 1899: 142-143; Koehler, 1909a: 171; Koehler, 1914a: 40-41.
Amphiactis duplicata Matsumoto, 1915: 66-67; Matsumoto, 1917: 146-147; Koehler, 1922b: 204-205, pl. 63, figs 1-4; Mortensen, 1927: 198.
Histampica duplicata: Clark, 1970: 73-74; Clark, 1977: 142; Paterson, 1985: 80, fig. 32.

Diagnosis *- adapted from Paterson (1985).*

D.D. up to 9mm, D.D./A.L. = *c.*1/4. Disc round, covered with large, thick overlapping scales. Central plate and primary rosette distinct, primary plates may have knobs in centre. Radial shields twice as long as wide, nearly half disc radius, separated by wedge of scales. Ventral interradial areas covered in scales slightly smaller than those on dorsal side. Oral shields diamond-shaped, rounded distally, equally long as broad. Adoral shields large, separating oral shield from first lateral arm plates, contiguous. Single large tricuspid apical papillae, 3-5 rounded oral papillae. Oral tentacle scale may be superficial and fall into series with oral papilla. Arms moderately long, able to coil. Dorsal arm plates fan-shaped, wider than long, contiguous basally. Ventral arm plates fan- or axe-shaped, may be indented laterally, sometimes contiguous basally. Arm spines three, flattened, conical, middle spine largest, *c.* same length as segment. Tentacle scales two, large, rounded or slightly elliptical.

Distribution and habitat

West Indies, Bay of Biscay to North Africa, east Pacific off Columbia to Ecuador (Paterson, 1985), South Africa: North of Richard's Bay (KZN) to Island Rock (KZN); depth range: 125-2870m.
Habitat: No information available.

Remarks

According to Paterson (1985), *H. duplicata* can be distinguished from other ophiactids by the arrangement and number of oral papillae being 3-5, the number of tentacle scales being two and the number of arm spines being only three. The syntypes are in the Museum of Comparative Zoology (MCZ OPH-4092, MCZ OPH-1262 and MCZ OPH-1263) and the type locality is Barbados, depth 183m.

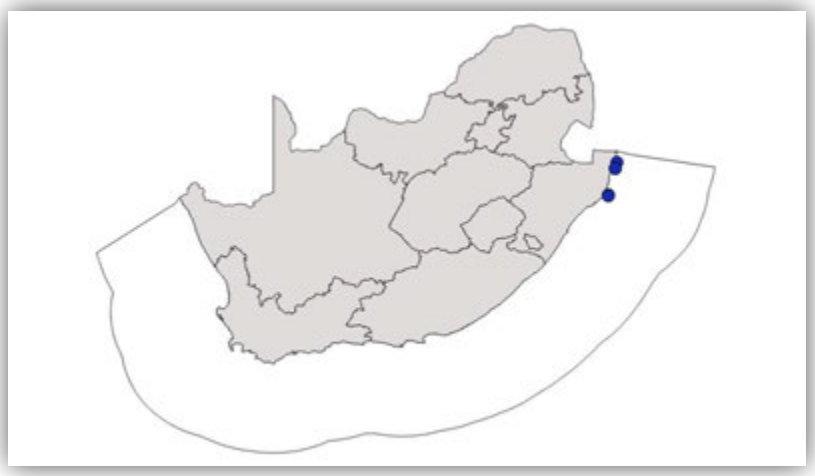

Figure 6.128. Distribution of *Histampica duplicata* in South Africa.

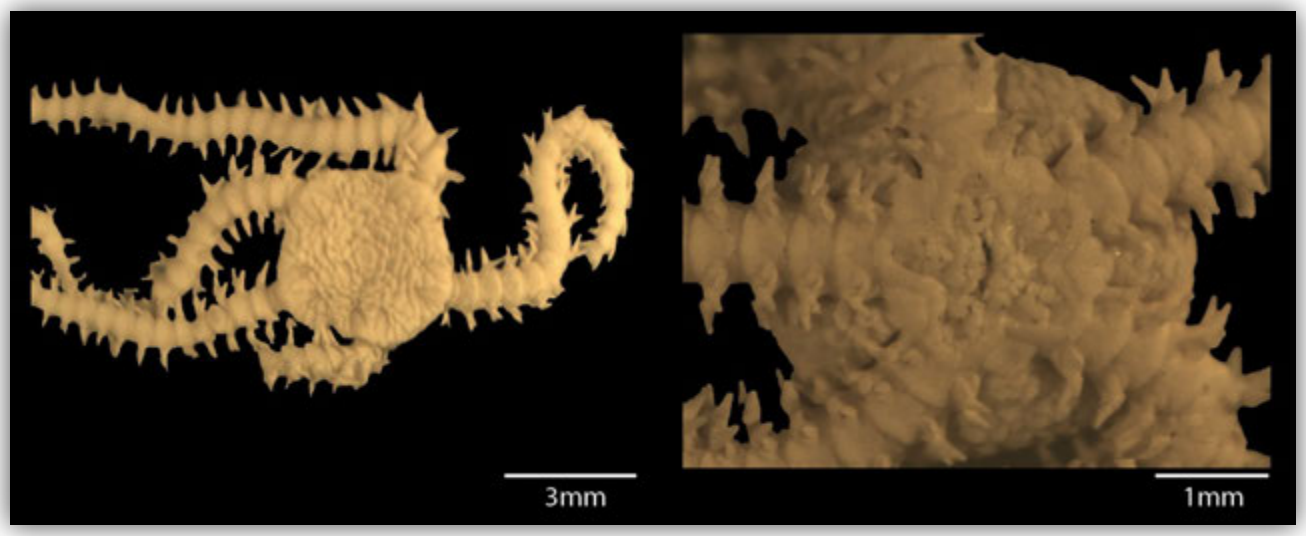

Figure 6.129. Dorsal (left) and ventral (right) views of *Histampica duplicata* (SAMC A22947).

Genus Ophiactis **Lütken, 1856**

Diagnosis *- adapted from Mortensen (1927).*

Disc scaling coarse, primary rosette often distinct. Scales with scattered spinelets or granules. Infradental papillae on apex of jaws, one or two distal oral papillae. Arm spines short.

Ophiactis abyssicola **(Sars, 1861)**

Figs 6.130 and 6.131.

Amphiura abyssicola Sars, 1861: 18-21, pl. 2, figs 7-12.
Ophiactis abyssicola: Ljungman, 1867b: 324; Lyman, 1882: 122; Clark, 1918: 304-305; Clark, 1923: 334-335; Mortensen, 1927: 202-203, fig. 114, Mortensen, 1933c: 347; Clark and Courtman-Stock, 1976: 104, 119, 161; Rodrigues *et al.*, 2011: 11, fig. 6.
Ophiactis cuspidata Lyman, 1879: 38.
Ophiactis poa Lyman, 1879: 40; Lyman, 1882: 119.
Ophiactis corallicola Koehler, 1895: 460-461, fig. 5.
Ophiactis echinata Koehler, 1898a: 48-49, pl. 5, figs 15, 16.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 8mm, D.D./A.L. = 1/3-8. Disc round, dorsal disc scales overlapping, primary rosette distinct, scattered conical spines on disc, concentrated on margin. Radial shields *c.* half to slightly more than disc radius in length, naked, D-shaped, large, separated by one or two rows of scales, approximate distally, not contiguous. Ventral interradial area with finer scales than dorsal, some scattered spines. Oral shields fan-, bell- or diamond-shaped, wider than long, adoral shields broadly contiguous. Apical papillae single, large, round. Distal oral papillae two, large, distalmost slightly larger. Arms five, simple, monoliliform distally. Dorsal arm plates diamond-shaped, twice as wide as long, not contiguous distally. Ventral arm plates pentagonal or fan shaped, either rounded distal edge, or with concave notch. Lateral arm plates meeting ventrally on distal arms only. Arm spines 3-4, erect, pointed or blunt, cylindrical, middle spine longest, half to two times longer than segment. Genital papillae absent. Tentacle scale one, large, oval. Colour in life orange with light purple-orange disc, grey, brown and some specimens with a pinkish tinge (Clark, 1923).

Distribution and habitat
European waters, Greenland, Australia (Mortensen, 1927; Rowe and Gates, 1995), South Africa: off Cape Columbine (NC) to off Still Bay (WC); depth range: 167-2743m.
Habitat: Green sand and mud.

Remarks
The type material is in the Museum of Comparative Zoology (syntypes: MCZ OPH-1161 and MCZ OPH-1188), type locality is Norway (Clark and Courtman-Stock, 1976), depth unknown.

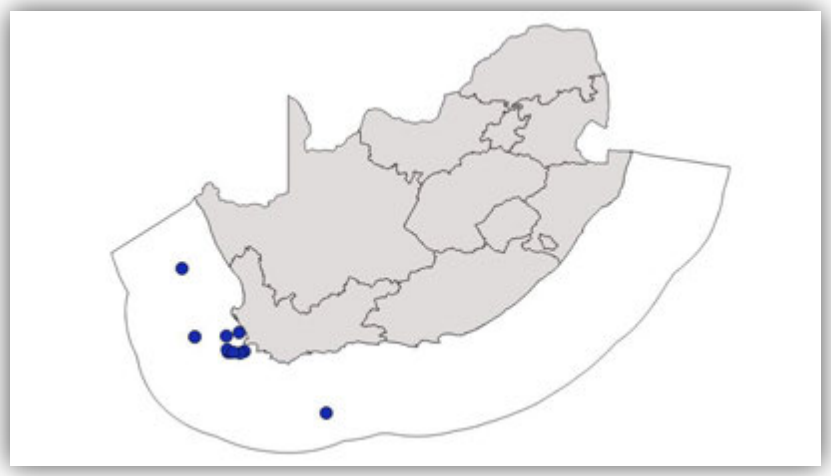

Figure 6.130. Distribution of *Ophiactis abyssicola* in South Africa.

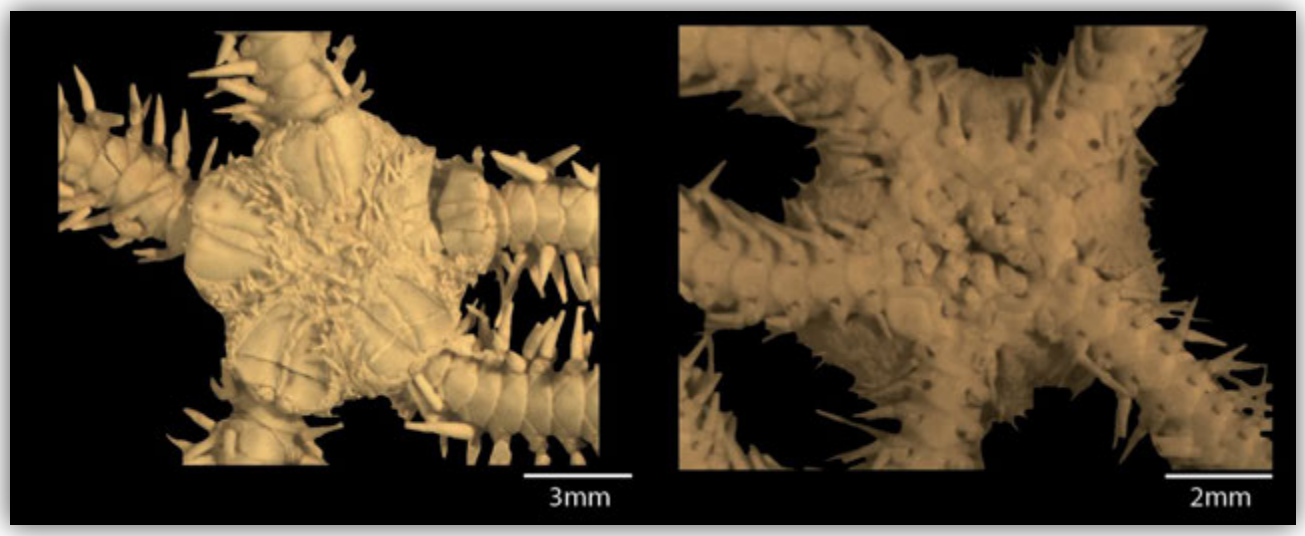

Figure 6.131. Dorsal (left) and ventral (right) views of *Ophiactis abyssicola* (SAMC A23238 (dorsal); SAMC A23238 (ventral)).

***Ophiactis carnea* Ljungman 1867**

Figs 6.132 and 6.133.

Ophiactis carnea Ljungman, 1867b: 324-325; Lyman, 1882: 120; Clark, 1923: 332-333, pl. 20, figs 3, 4; Mortensen, 1933c: 342-345, figs 54-56; Stephenson *et al.*, 1937: 380; Eyre and Stephenson, 1938: 39; Clark, H.L., 1939: 76; Clark, A.M., 1952: 199; Balinsky, 1957: 11-12; Kalk, 1958: 197, 200, 215, 237; Morgans, 1959: 414, 422; 1962: 303; Macnae and Kalk, 1962: 114; Balinsky, 1969: 106, 129; Day *et al.*, 1970: 81; Clark and Rowe, 1971: 82, 104, fig. 31e; Clark and Courtman-Stock, 1976: 104, 119, 161, fig. 165; Clark, 1980: 548, 549; Vine, 1986: 195; Olbers *et al.*, 2014: 16, pl. 3A; Mbongwa, 2013: 15.
Ophiactis africana Koehler, 1911: 17-19, pl. 3, figs 4, 5.
Ophiactis africana capensis: Hertz, 1927b: 6.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 6mm, D.D./A.L. = 1/5-6. Arms five, simple. Disc round, dorsal disc scales thin and overlapping, primary rosette not distinct, sometimes dark spot in centre of disc visible, scattered spines close to disc margin, may be absent. Radial shields elongated D-shaped, moderate in size, single disc scale separating them, touching distally, length half to one-third disc radius. Ventral interradial area covered in scales, no spines. Oral shields diamond-shaped, adoral shields broadly contiguous. Distal oral papillae single, large, round and flattened. Dorsal arm plates broadly rhombic, broadly contiguous, becoming fan-shaped, as long as wide. Ventral arm plates fan-shaped or octagonal, distal ends becoming rounded. Arm spines 3-5, uppermost arm spines thin and tapering, middle spine longest, blunt, lowest spine stubby and short. Longest arm spine slightly longer than length of segment, shortest spine shorter than segment. Tentacle scale one, large, oval. Colour in life reddish brown to brown, with white patches.

Distribution and habitat
Mozambique, tropical Indo-Pacific, Red Sea, South East Arabia, Persian Gulf, (Kalk, 1958; Clark and Rowe, 1971; Vine, 1986), South Africa: Cape Town (WC) to Cape St Lucia (KZN); depth range: 0-220m (Clark and Courtman-Stock, 1976).
Habitat: Coral reefs, *Cymodocea* beds, rock, sand and shell.

Remarks
Some specimens at hand had light patches on the distal portions of the radial shields, similar to *Ophiactis savignyi* and *O. picteti*. The syntypes are in the Swedish Museum of Natural History (SMNH-Type-1422) and the type locality is Port Natal (Durban), depth unknown.

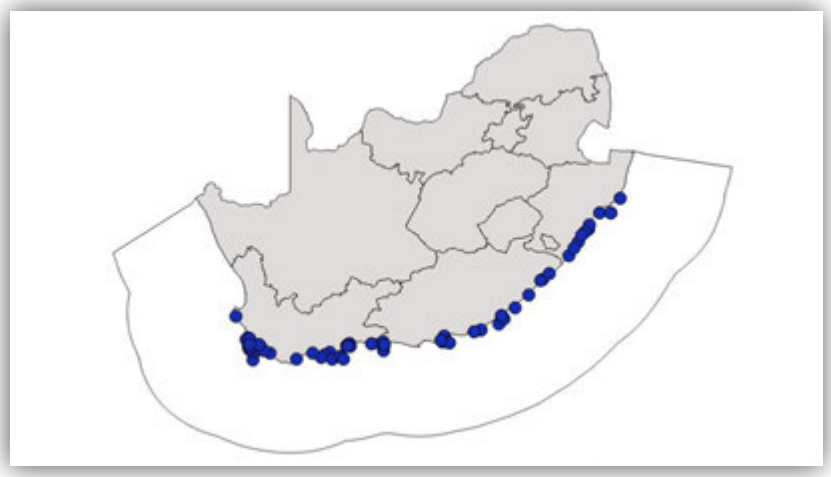

Figure 6.132. Distribution of *Ophiactis carnea* in South Africa.

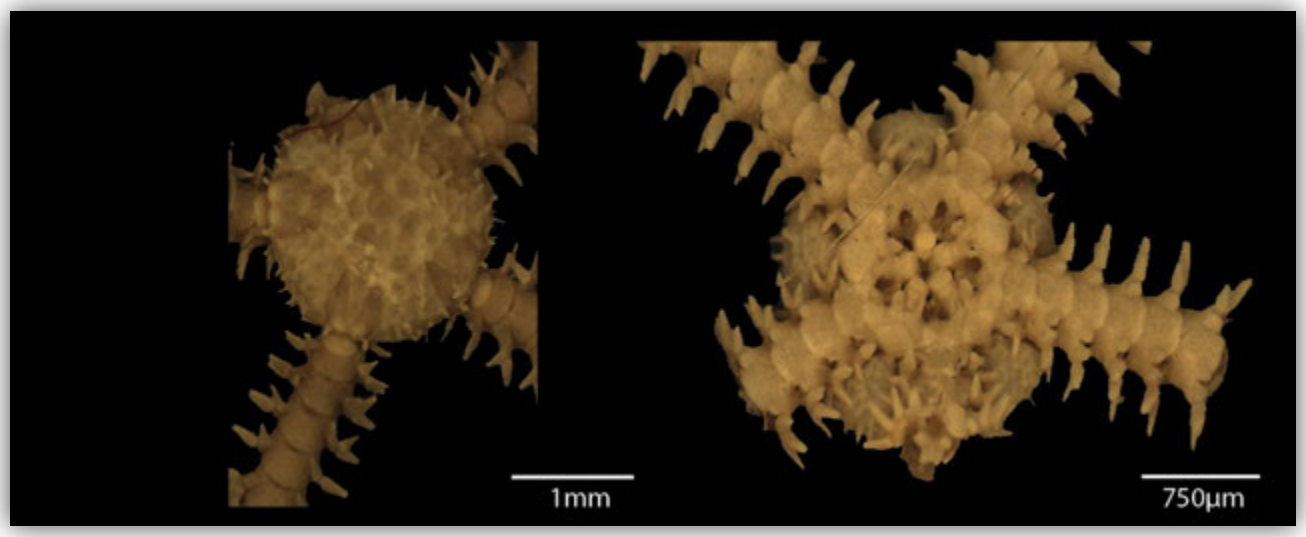

Figure 6.133. Dorsal (left) and ventral (right) views of *Ophiactis carnea* (DNSM ECH21B).

***Ophiactis nidarosiensis* Mortensen, 1920**
Figs 6.134 and 6.135.

Ophiactis nidarosiensis Mortensen, 1920: 60-63, fig. 5; Mortensen, 1927: 200, fig. 111; Mortensen, 1933c: 346-347, fig. 58a; Clark and Courtman-Stock, 1976: 163; Alva and Vadon, 1989: 829, 839, fig. 5c, d.

Diagnosis *- adapted from Mortensen (1920) and Clark and Courtman-Stock (1976).*
D.D. up to 3.5mm, D.D./A.L. = 1/5-6. Disc covered in coarse scales and sparsely scattered short spines, primary rosette not distinct. Radial shields *c.* half disc radius, not contiguous, separated by 2-3 scales. Ventral interradial areas with more delicate scales, usually with no spines. Fissiparous, arms usually six but sometimes five or seven. Dorsal arm plates fan-shaped, broadly in contact, longer than wide. Ventral arm plates pentagonal, distal edge convex, longer than wide, proximal edge narrow,

truncated and/or convex. Lateral arm plates prominent. Oral shields rhombic, as long as wide. Adoral shields large, contiguous. Distal oral papillae two, sometimes one. Arm spines up to four, upper spine in larger specimens longer, smoother and thinner, three lower spines equal in size, finely serrated, erect, about equal to segment length. Tentacle scales one, round.

Distribution and habitat

Namibia, North Atlantic (Alva and Vadon, 1989), South Africa: off Orange River mouth (NC); depth range: 175-307m.
Habitat: No information available.

Remarks

Mortensen (1933c) suggested that *Ophiactis nidarosiensis* is very similar to *O. savignyi* and *O. plana* because they are also fissiparous. He suggested that the most reliable character for differentiation is the shape of the dorsal arm plates, which are narrow fan-shaped, broadly in contact and longer than wide, whereas in *O. plana* they are fan-shaped, barely contiguous proximally, separated distally and wider than long and in *O. savignyi* oval to elliptical, twice as wide as long and rounded distally.

No specimens were available for examination. Clark and Courtman-Stock (1976) and Mortensen (1933c) reported *O. nidarosiensis* to occur in southern Africa, but gave no details of distribution or specimens. Later, Alva and Vadon (1989) reported specimens to have been collected by the Instituto de Ciencias de Mar in Namibia, one specimen was collected on the Namibia / South African border off the Orange River at 307m. The syntypes are in the Natural History Museum of Denmark (ZMUC OPH-322, ZMUC OPH-323, ZMUC OPH-324 and ZMUC OPH-216) and the Museum of Comparative Zoology (MCZ OPH 4781). Type locality is Norway, depth unknown.

Figure 6.134. Distribution of *Ophiactis nidarosiensis* in South Africa.

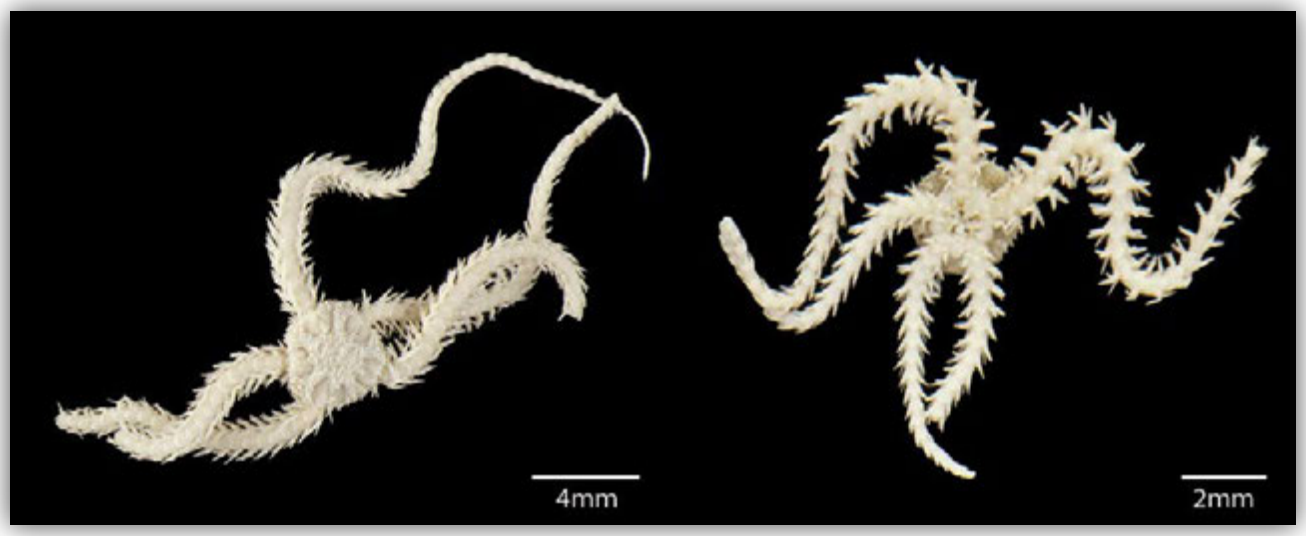

Figure 6.135. Dorsal (left) and ventral (right) views of *Ophiactis nidarosiensis* (ZMUC OPH-216)[8].

***Ophiactis* cf. *picteti* (De Loriol, 1893)**

Figs 6.136 and 6.137.

Ophiocnida picteti De Loriol, 1893b: 405-407, pl. 13, fig. 2.
Ophiactis picteti: Clark, 1915a: 267; Clark and Rowe, 1971: 82,104; Cherbonnier and Guille, 1978: 123-125, fig. 56; Sloan *et al.*, 1979: 101-102; Humpreys, 1981: 10, 21; Liao and Clark, 1995: 216; Milne, 2012: 155; Olbers *et al.*, 2015: 95, pl. 3C, D.
Ophiactis sinensis Mortensen, 1934: 11, figs 7-9, pl. 1, fig. 3.

Diagnosis *- adapted from Cherbonnier and Guille (1978).*
D.D. up to 6mm, D.D./A.L. = 1/9. Disc round, dorsally covered with overlapping scales, many conical small spinelets mainly in interradial areas and on margin. Ventral interradial areas with finer scales, scattered conical spines. Arms five, long, simple. Radial shields elongated, narrow triangular, length at least two-thirds disc radius, each pair separated by four enlarged scales, distally approximating or contiguous, light patch on distal part of each radial shield. Genital slits ending at edge of disc, no distinct scales, genital papillae absent. Oral shields spearhead-shaped or oval, slightly wider than long, may be truncated on distal side. Adoral shields contiguous interradially. Distal oral papillae 2-3. Up to seven arm spines (usually six), short, longest less than twice segment length, tapering to blunt tips, three uppermost ones stout, conical and rugose, remaining spines elongated and decreasing in size toward ventral side. Dorsal arm plates oval, becoming elliptical, wider than long, distal edge convex, broadly contiguous. Ventral arm plates hexagonal, edges rounded in proximal part of arm, becoming flat-truncated on both sides, slightly wider than long. Single tentacle scale large, round. Colour in life, disc and arms brown with white, marbled, arms banded sometimes with dark spots, ventrally arms white, spinelets white.

Distribution and habitat
Madagascar, Tanzania, Kenya, East Indies, Indo-Malayan region, Australia, (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Humpreys, 1981; Rowe and Gates, 1995), South Africa: Trafalgar (KZN) to Sodwana Bay (KZN); depth range: 0-50m.
Habitat: Coral patches and coral reef flats.

[8] ZMUC OPH-216 has only five arms but usually this species has six arms.

Remarks
According to Olbers *et al.* (2015) this was a new record for South Africa. They also confirmed that South African specimens of *O. picteti* have a narrow median distal lobe on the oral shields, as suggested by Sloan *et al.* (1979) for Indian Ocean specimens.

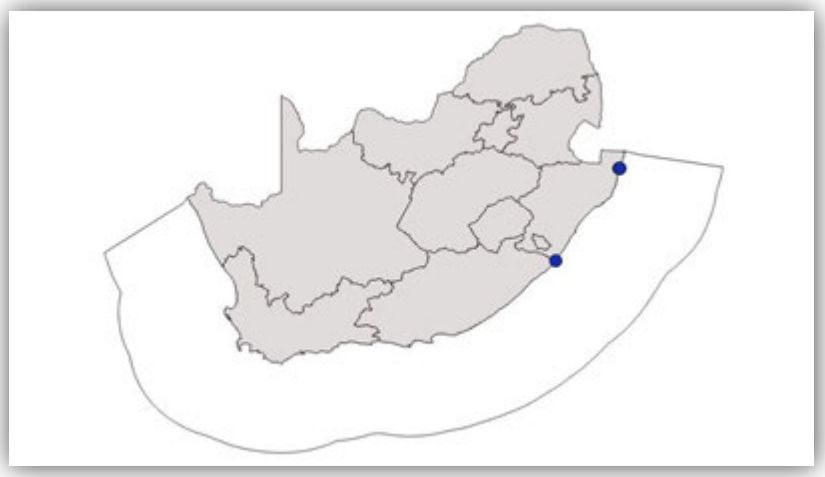

Figure 6.136. Distribution of *Ophiactis* cf. *picteti* in South Africa.

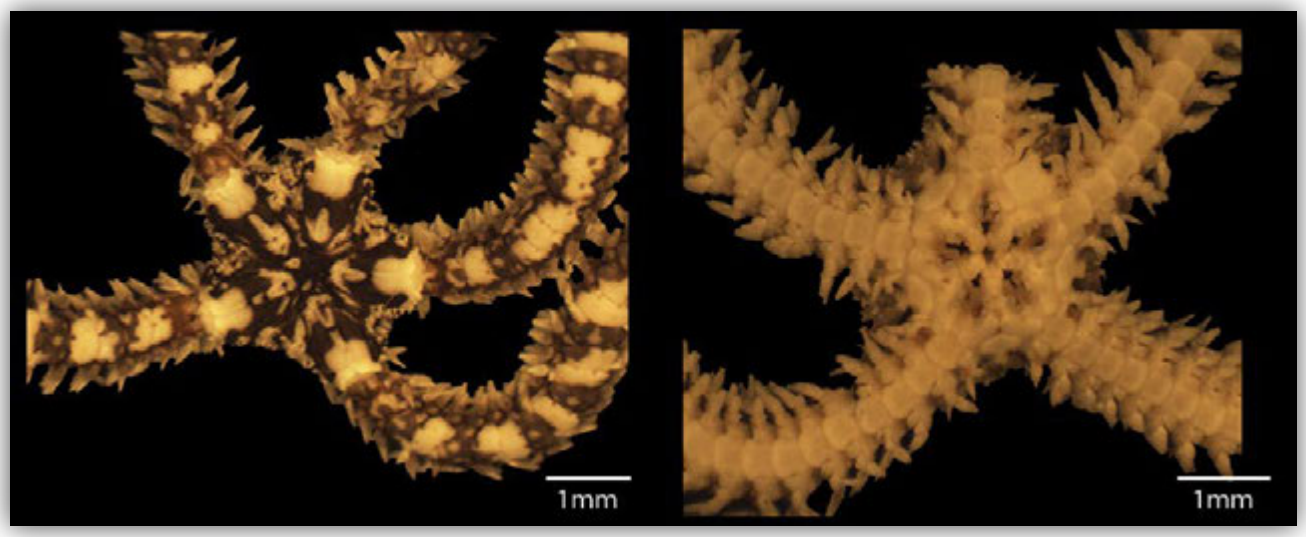

Figure 6.137. Dorsal (left) and ventral (right) views of *Ophiactis* cf. *picteti* (SAMC A74065).

Ophiactis plana Lyman, 1869
Figs 6.138 and 6.139.

Ophiactis plana Lyman, 1869: 330-331; Clark, 1915a: 264; Clark, 1923: 333; Mortensen, 1933c: 345-346, fig. 57; Clark, H.L., 1939: 76-77; Day and Morgans, 1956: 308; Clark, 1974: 464-465; Olbers *et al.*, 2014: 16, pl. 3B.

Diagnosis *- adapted from Mortensen (1933c).*
D.D. up to 4mm, D.D./A.L. = 1/3-4. Disc covered with moderately coarse, thin, overlapping scales, may have spines. Interradial areas with finer scales. Radial shields relatively small, D-shaped, less than half disc radius, not contiguous. Oral shields rhombic or rounded triangular, almost circular, as long as wide. Adoral shields may be contiguous. Distal oral papillae one, large, triangular, apical tooth present. Arms simple, usually six, fissiparous species. Dorsal arm plates broad fan-shaped, barely contiguous proximally, separated distally, wider than long. Ventral arm plates truncated pentagonal, distal edge

straight or slightly concave. Arm spines up to four, stout, smooth, tapering to blunt tips, shorter than segment length. Tentacle scale one, large, round or oblong. Colour variable, green and reddish in different shades.

Distribution and habitat

Mozambique, Red Sea, Gulf of Aden, North Carolina, Gulf of Mexico, Bermuda (Clark, 1915a; Clark, H.L., 1939; Felder and Camp, 2015), South Africa: Cape Town (WC) to Tugela River (KZN); depth range: 0-412m.

Habitat: Rock, shell, mud, sand, coral and stones.

Remarks

Even though *Ophiactis flexuosa* only has five arms, Clark (1974) suggested that *O. lymani* and *O. flexuosa* be synonymised with *O. plana,* while according to Mortensen (1933) and Clark, H.L. (1946), *O. profundi* Lütken and Mortensen, 1899 and *O. plana* may be also be synonyms (Rowe and Gates, 1995). In addition, various authors have commented on the similarities of various features among ophiactid species (Lyman, 1882; Mortensen, 1933c; Madsen, 1970). According to Tim O'Hara (pers. comm.), a global phylogeography of this species is required because tropical specimens in the south west Pacific are a separate clade from those in the southern Ocean (including Tasmania and the South west Indian Ocean Ridge). Given that *O. plana* was originally from the Caribbean, the correct identity of any South African specimens is therefore unclear at present.

The type material is in the Museum of Comparative Zoology. Holotype MCZ OPH-1184, with additional type material MCZ OPH-1185, MCZ OPH-1242 and MCZ OPH-4632. Type locality is off Carysfort Reef, Florida, depth 210m.

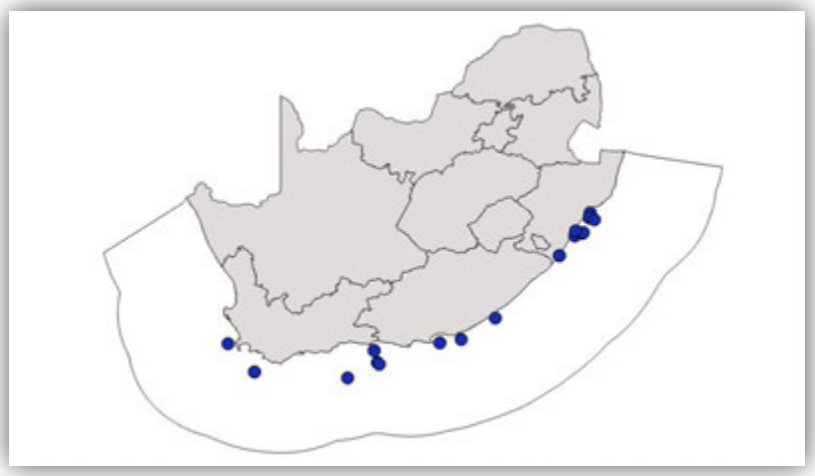

Figure 6.138. Distribution of *Ophiactis plana* in South Africa.

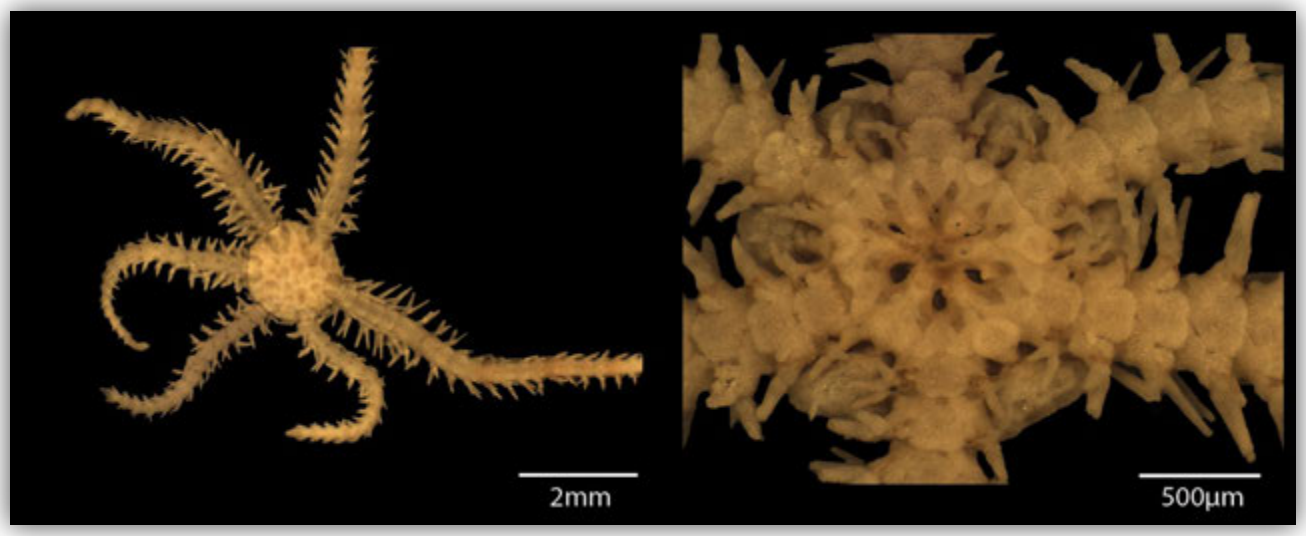

Figure 6.139. Dorsal (left) and ventral (right) views of *Ophiactis plana* (DNSM ECH23B).

***Ophiactis savignyi* (Müller and Troschel, 1842)**

Figs 6.140 and 6.141.

Ophiolepis savignyi Müller and Troschel, 1842: 95.
Ophiactis sexradia Grube, 1857: 343; De Loriol, 1893b: 398-401; Koehler, 1898b: 72.
Ophiolepis sexradia Grube, 1857: 343.
Ophiactis reinhardtii Lütken, 1869: 262-264, pl. 3, fig. 7a, b.
Ophiactis maculosa Von Martens, 1870: 248.
Ophiactis savignyi: Lyman, 1882: 115; Clark, 1932: 204; Clark, H.L., 1939: 77; Day and Morgans, 1956: 308; Balinsky, 1957: 14; Clark and Rowe, 1971: 82, 83, 103; Clark and Courtman-Stock, 1976: 104, 119, 164, figs 156, 161; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 125-128, fig. 57; Sloan *et al.*, 1979: 102; Marsh, 1986: 70; Vine, 1986: 195; Sastry, 1991: 376, pl. 3, fig. 14; Hendler *et al.*, 1995: 148-150, fig. 70; Liao and Clark, 1995: 217-218, fig. 110; Pomory, 2003: 74-76, fig. 33; Laguarda-Figueras *et al.*, 2009: 178, fig. 71; Picker and Griffiths, 2011: 76; Milne, 2012: 155; Mbongwa, 2013: 15.
Ophiactis conferta Koehler, 1905a: 25-26, pl. 3, figs 15-17.
Ophiactis versicolor Clark, H.L., 1939: 81-82, fig. 36.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 5mm, D.D./A.L. = *c.*1/7. Arms up to seven, usually six, sometimes three, fissiparous. Disc round, dorsal disc scales armed with scattered spinelets, usually marginal. Radial shields moderately large, naked, elongated triangular or D-shaped, length varies from approximately half to just over disc radius, each pair separated by single row of elongated scales, contiguous distally. Ventral interradial area with thick imbricating scales, sometimes with scattered spines. Oral shields rhombic, longer than wide, adoral shields not always contiguous. Oral papillae two, with apical tooth, tooth may be rubbed off. Genital slits surrounded by larger scales. Dorsal arm plates oval to elliptical, twice as wide as long, rounded distally, with median distal lobe emphasised by two spots, developing after first 2-3 segments. Ventral arm plates hexagonal, wide as long, proximally becoming pentagonal and longer than wide. Arm spines up to six, short, finely serrated, no more than single segment length, stouter proximally, becoming slightly elongated and blunt. Tentacle scale single, large, rounded. Colour in life variable, generally green with green and white markings, arms similarly banded, ventrally lighter, arms banded with green, some specimens with white patch on distal edge of each radial shield.

Distribution and habitat
Cosmopolitan (Clark, 1915a; Kalk, 1958; Hendler *et al.*, 1995), South Africa: Umgazana (EC) to Kosi Bay (KZN); depth range: 0-1000m.

Habitat: Associated with sponges, sea-grass, rock, coral fragments, coralline algae, fouling communities and intertidal algal turf.

Remarks

Abundant in KZN on rocky shores, among turf algae. A well-studied species, known to have variable morphological characters.

High polymorphism (coloration, number of arms, shape of arm plates, radial shields, number of oral papillae and arm spines) in Indo-Pacific species of *Ophiactis* is astounding. The uncertainty of characters and identity of many specimens is documented by many authors (De Loriol, 1893b; Clark, 1915a; Clark, 1923; Mortensen, 1933c; Mortensen, 1933d; Clark, H.L., 1939; Balinsky, 1957; Madsen, 1970; Clark, 1974; Clark and Courtman-Stock, 1976; Sloan *et al.*, 1979). The Indo-Pacific ophiactids require comprehensive revision, as it is believed that many of the species are in fact the same. In this study, the differences between *O. hemiteles* and *O. picteti* were so minor that it is doubtful both exist in South African waters. Two noteworthy studies, Hendler *et al.* (1995) and Pomory (2007), both reported that specimens may have three oral papillae as opposed to two, as reported here. The type material is in the Museum of Comparative Zoology (paratype: MCZ OPH-3926), type locality is the Philippines, depth unknown.

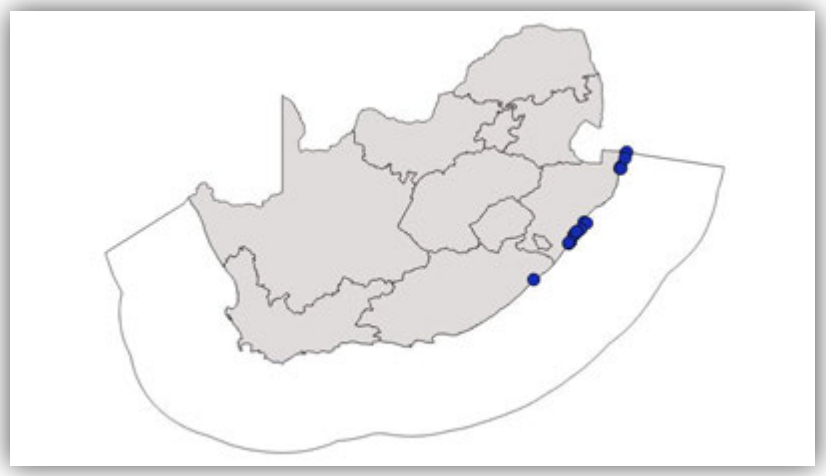

Figure 6.140. Distribution of *Ophiactis savignyi* in South Africa.

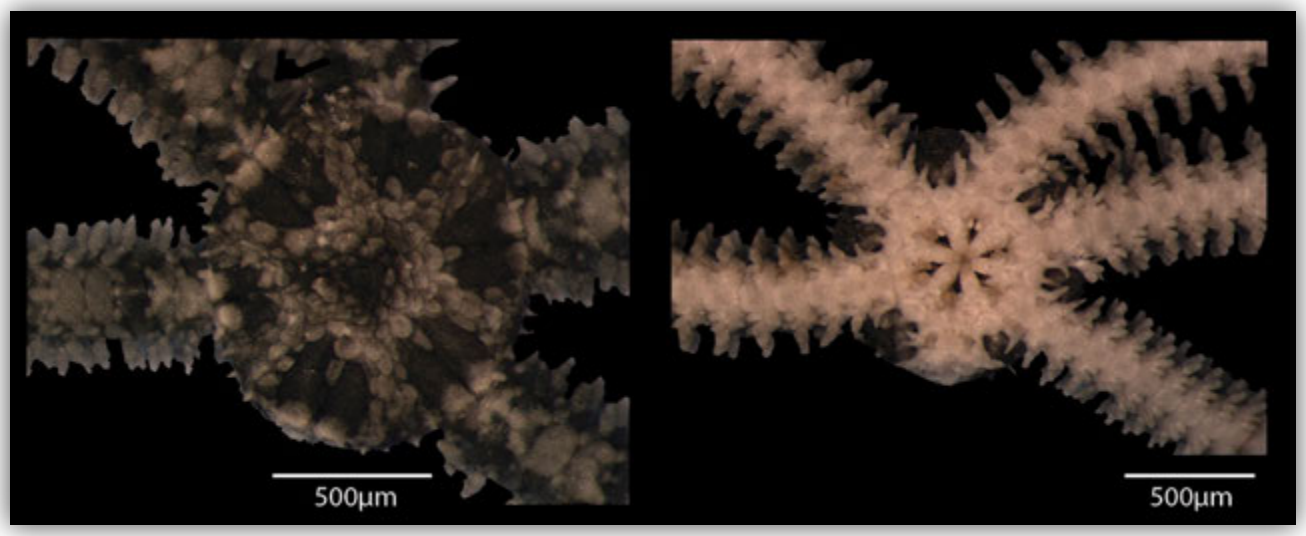

Figure 6.141. Dorsal (left) and ventral (right) views of *Ophiactis savignyi* (RMCA MT2259).

Family OPHIOCOMIDAE Ljungman, 1867

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
Disc covered in dense granules, may be intermixed with spinelets. Radial shields not distinct, except in *Ophiopsila*. Oral and adoral shields well-developed with adoral shields only being contiguous in *Ophiopsila*. Teeth broad, square. Dental papillae present beneath lowest tooth, oral papillae present, up to six. Arms long and stout, often widening beyond base and connected to disc ventrally. Arm plates well-developed both dorsally and ventrally. Arm spines erect, most often long or stout. Tentacle scales oval, except in *Ophiopsila* where inner scale elongated and sword-like.

Genus Ophiocoma Agassiz, 1836

Diagnosis *- adapted from Devaney (1970) and Clark and Courtman-Stock (1976).*
Majority of species large, disc diameter often exceeding 20mm. Disc covered with granules, usually concealing scaling on disc and may extend onto ventral interradial area. Oral papillae up to six, outer one usually widest. Tooth papillae always present, few to numerous, with superficial ones in series with oral papillae. Oral shields without granules, large, oval, hexagonal or pentagonal. Dorsal arm plates wider than long, fan-shaped, oval or hexagonal. Ventral arm plates more or less square-shaped, proximal side straight, distal side straight to concave. Arm spines 3-7, smooth, stout, sometimes alternating three and four on successive arm segments or on opposite sides of same segment; lower arm spines sometimes flattened and spatulate, while upper ones cylindrical or cigar-shaped. Tentacle scales one or two.

Ophiocoma (Breviturma) brevipes Peters, 1851

Figs 6.142 and 6.143.

Ophiocoma brevipes Peters, 1851: 466; Marktanner-Turneretscher, 1887: 303; De Loriol, 1893a: 25, 26, pl. 23, fig. 4; Clark, 1908: 296; Clark, 1911: 256; Koehler, 1922b: 319-322, pl. 72, figs 6-9; Clark, 1932: 205; Devaney, 1968: 45; Devaney, 1970: 13; Clark and Rowe, 1971: 86, 119; Devaney, 1974: 151-152; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 168-169, pl. 10, figs 3, 4; Sloan *et al.*, 1979: 104; Clark, 1980: 534; Tortonese, 1980: 125, fig. 11; Humpreys, 1981: 10, 23; James, 1982: 39-40, pl. 2B; Marsh, 1986: 71; Sastry, 1991: 380, pl. 4, fig. 21; Liao and Clark, 1995: 258-260, fig. 138, pl. 19, fig. 6; Rowe and Gates, 1995: 385; Rowe and Richmond, 2004: 3292; Olbers and Samyn, 2012: 140-143, pls 1a-g, 2a-c; Mbongwa, 2013: 15.
Ophiocoma brevispinosa Smith, 1876: 40.
Ophiopeza danbyi Farquhar, 1897: 189-190, pl. 14, figs 7, 8; Clark, 1915a: 291.
Non *Ophiocoma brevipes*: Stöhr *et al.*, 2008: 553, 555, fig 5e.
Ophiocoma (*Breviturma*) *brevipes* Stöhr *et al.*, 2013: 10-13, figs 2d, 4, 5a, d, g, j, m, p.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D. up to 25mm. Disc with small, fine, spherical granules closely packed on both dorsal and ventral side. Oral shields round to oval with dark markings. Adoral shields not contiguous. Oral papillae 4-5. Teeth wide and rounded. Genital slits clearly visible, elongated and bordered with slightly more prominent granules. Arms banded on the dorsal side. Dorsal arm plates oval, wider than long, broadly contiguous. Ventral arm plates nearly as wide as long, bluntly pointed on the proximal side, not contiguous distally. Arm spines up to six, uppermost thickest on the proximal part of the arm, longest spine shorter than, or equal to, segment length. Tentacle scales two, oval. Colour in life, disc colour patterns variable, with a combination of light greens, whites, yellows and browns in blotchy star, or simply no particular pattern.

Distribution and habitat

Mozambique, north-western parts of the Indian Ocean, tropical Indo-West Pacific (Rowe and Richmond, 2004), South Africa: Aliwal Shoal (KZN) to Kosi Bay (KZN); depth range: 0-54m.
Habitat: Associated with coral heads or boulders, on fine to coarse sand and at the bases of algae in the sandy littoral zone.

Remarks

Additional notes on *O. brevipes* are given by Olbers and Samyn (2012), who describe this as a new record for South Africa and include notes on the juveniles, which differ from adults.

The type material is in the Museum of Natural History at the University of Berlin (syntypes ZMB Ech 4660, ZMB Ech 961, ZMB Ech 962 and ZMB Ech 963) and the type locality is Quirimbas Island, Mozambique, depth unknown.

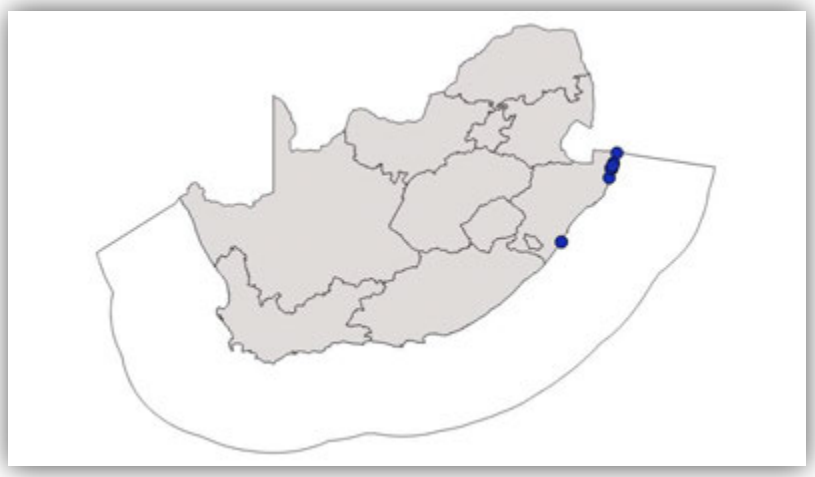

Figure 6.142. Distribution of *Ophiocoma* (*Breviturma*) *brevipes* in South Africa.

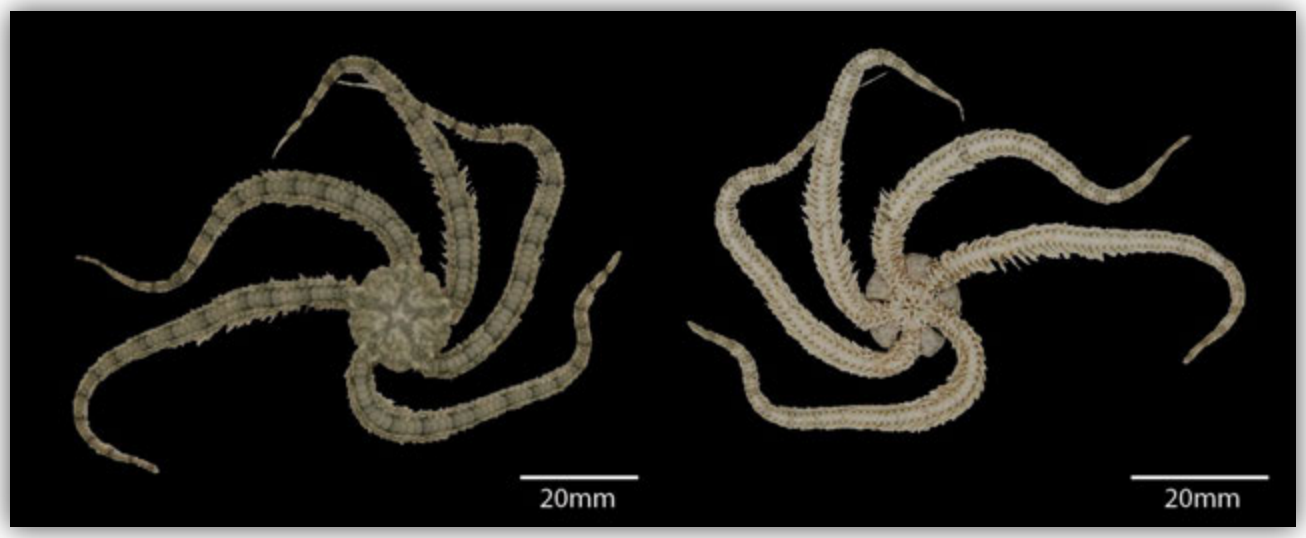

Figure 6.143. Dorsal (left) and ventral (right) views of *Ophiocoma* (*Breviturma*) *brevipes* (RMCA MT2194).

Ophiocoma (Breviturma) dentata Müller and Troschel, 1842

Figs 6.144 and 6.145.

Ophiocoma dentata Müller and Troschel, 1842: 99, pl. 7, figs 3, 3a; Devaney, 1968: 45; Devaney, 1970: 13; Clark and Rowe, 1971: 86, 119, pl. 18, figs 2, 3; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 168, pl. C, figs 3, 4; Tortonese, 1980: 125, figs 11A, B; James, 1982: 40, pl. 2C, D; Guille and Vadon, 1985: 63; Marsh, 1986: 71; Sastry, 1991: 380, pl. 4, fig. 22; Liao and Clark, 1995: 260-261, fig. 139; Rowe and Gates, 1995: 386; Price and Rowe, 1996: 76; Rowe and Richmond, 2004: 3292; Olbers and Samyn, 2012: 143-144, pl. 2d, e; Mbongwa, 2013: 15.
Ophiocoma insularia Lyman, 1862: 80-81; Macnae and Kalk, 1958: 130.
Ophiocoma ternispina Von Martens, 1870: 252-253.
Ophiocoma variegata Smith, 1876: 39.
Ophiocoma (*Breviturma*) *dentata* Stöhr *et al*., 2013: 13-17, figs 2e, f, 5b, e, h, k, n, q.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D up to 14.3mm. Disc covered in granules. Radial shields not distinct. Oral shields round, as long as wide, with marbled pattern. Adoral shields small, not contiguous. Dental papillae broad, not extending far into mouth. Dorsal arm plates broad, elliptical and contiguous. Ventral arm plates square with rounded corners, rounded distal edge, as wide as long, contiguous. Arm spines four, broadly and irregularly banded once or twice with light brown, upper arm spines thick, blunt, somewhat flattened and slightly shorter than lower ones. Tentacle scales two, oval. Colour in life variegated with brown, white and beige, both dorsally and ventrally with the presence of small dark brown spots.

Distribution and habitat
Tropical Indo-West Pacific, Western Indian Ocean (Macnae and Kalk, 1958; Rowe and Gates, 1995; Rowe and Richmond, 2004), South Africa: Aliwal Shoal (KZN) to Kosi Bay (KZN); depth range: 0-35m. Habitat: Sub-littoral zone, under boulders and associated with coral and coral debris on sand or rubble.

Remarks
The holotype is in the Museum of Natural History at the University of Berlin (ZMB Ech 931), type locality Celebes (Islands of Sulawesi, Indonesia), depth unknown.

Additional notes on *O. dentata* are given in Olbers and Samyn (2012), where it is described as a new record for South Africa.

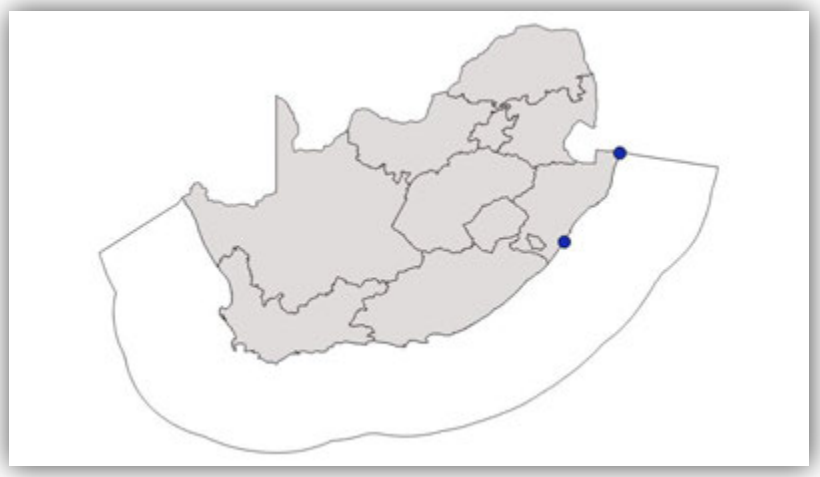

Figure 6.144. Distribution of *Ophiocoma* (*Breviturma*) *dentata* in South Africa.

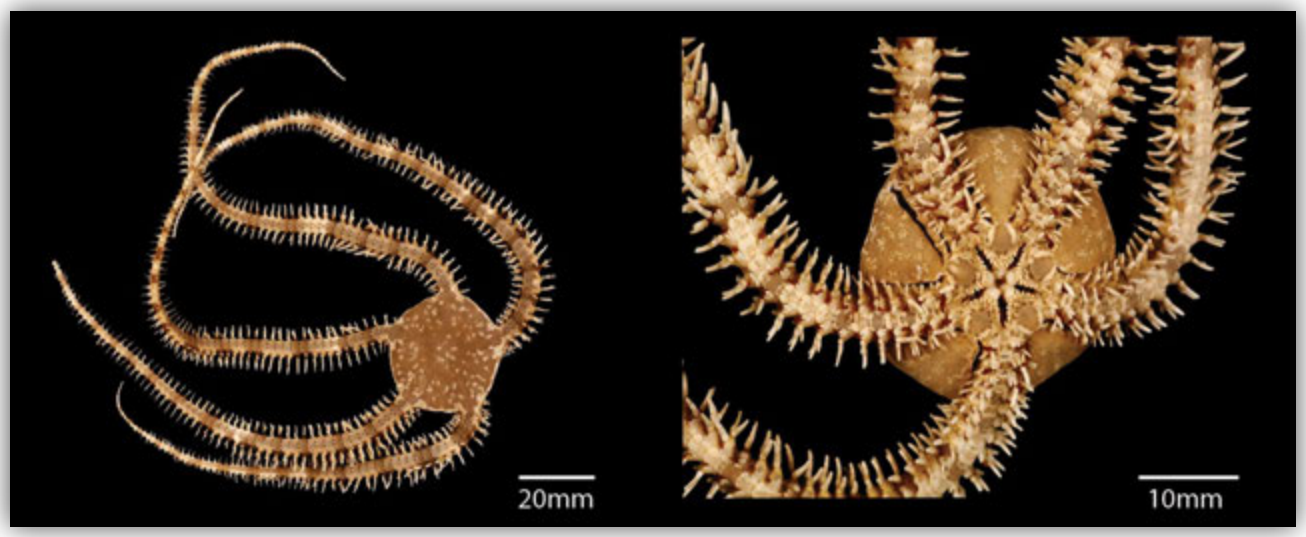

Figure 6.145. Dorsal (left) and ventral (right) views of *Ophiocoma* (*Breviturma*) *dentata* (RMCA MT2380).

***Ophiocoma (Breviturma) doederleini* de Loriol, 1899**

Figs 6.146 and 6.147.

Ophiocoma doederleini De Loriol, 1899: 30, pl. 3, fig. 2; Devaney, 1968: 69; Devaney, 1970: 12-18, figs 18, 14, 22; Devaney, 1974: 154; Sloan *et al.*, 1979: 104, figs 8-10; Clark, 1980: 534; Humpreys, 1981: 10, 24; Marsh, 1986: 71; Rowe and Gates, 1995: 396; Olbers and Samyn, 2012: 144-145, pls 2f, g, 3a, b.
Ophiocoma dentata Lütken, 1859: 165 (non Müller and Troschel, 1842); Clark, 1921: 121.
Ophiocoma (*Breviturma*) doederleini Stöhr *et al.*, 2013: 7-10, figs 2a-c, 3.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D. up to 30mm. Disc covered in granules both dorsally and ventrally. Radial shields not distinct. Oral shields large, round to oval, longer than wide. Oral papillae up to six, distalmost broadest. Teeth broad, square. Adoral shields not contiguous. Genital slits long, genital papillae present. Dorsal arm plates fan-shaped, wider than long, distal edge rounded, broadly contiguous. Ventral arm plates fan-shaped with distal edge rounded. Arm spines annulated, flat and tapering proximally, but remaining spines tapering, shortest arm spine longer than segment length. Tentacle scales 2-3, large, oval. Colour in life greyish brown dorsally and ventrally either with fine black reticulating lines, white-ringed black spots, or speckled with light spots.

Distribution and habitat
Indian Ocean and west central Pacific Ocean (Rowe and Gates, 1995), South Africa: Sodwana Bay (KZN) to Kosi Bay (KZN); depth range: 12-20m.
Habitat: Under large boulders on gravel.

Remarks
Additional notes of *Ophiocoma* (*Breviturma*) *doederleini* are given in Olbers and Samyn (2012) who describe it as a new record for South Africa.

According to Devaney (1970) the annulation of the arm spines is used in the field as an easy character to separate *Ophiocoma* (*Breviturma*) *dentata* from *Ophiocoma* (*Breviturma*) *doederleini,* being absent in *dentata* but present in *doederleini*.

The holotype is in the Museum of Natural History, Genève (MHNG INVE 71892) and the type locality is Mauritius, depth unknown.

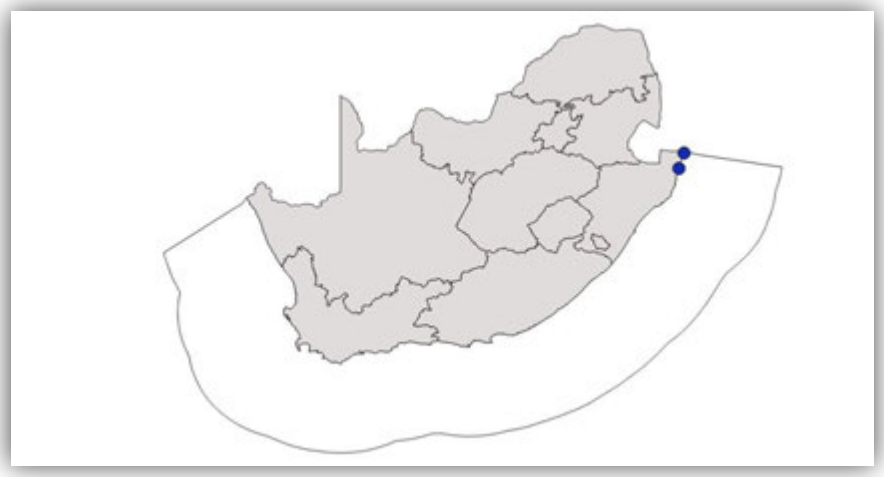

Figure 6.146. Distribution of *Ophiocoma* (*Breviturma*) *doederleini* in South Africa.

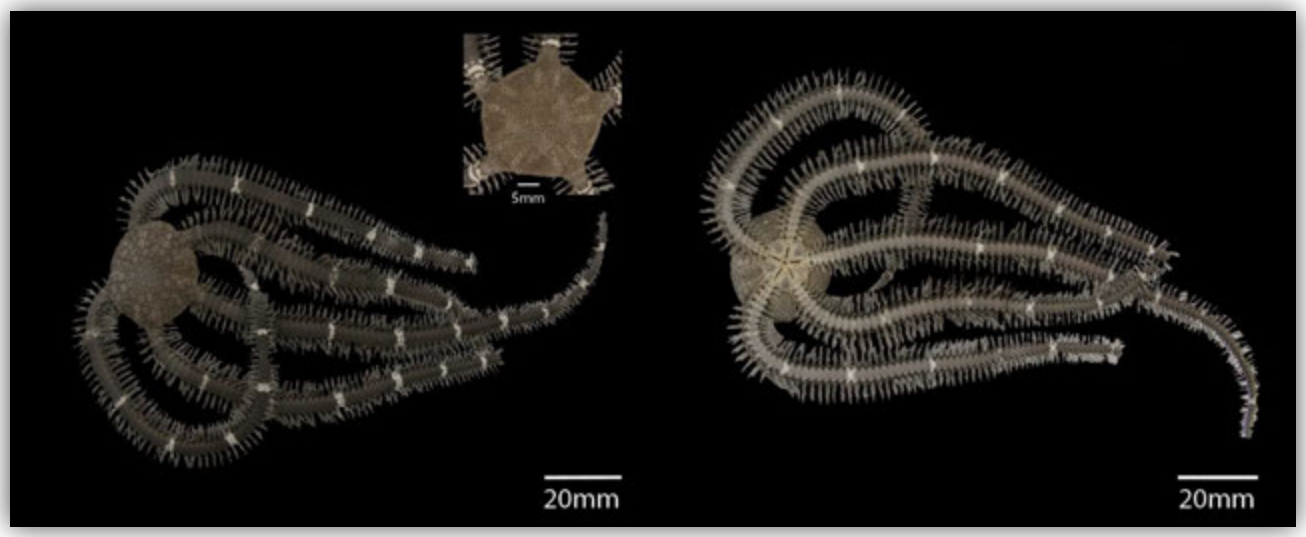

Figure 6.147. Dorsal (left) and ventral (right) views of *Ophiocoma* (*Breviturma*) *doederleini*. Inset: variable dorsal disc colouration, RMCA MT2249 (dorsal and ventral); RMCA MT2250 (inset).

***Ophiocoma erinaceus* Müller and Troschel, 1842**

Figs 6.148 and 6.149.

Ophiocoma erinaceus Müller and Troschel, 1842: 98; Kalk, 1958: 207, 216, 237; Clark, 1967: 47; Devaney, 1968: 173; Devaney, 1970: 33, figs 45-47; Clark and Rowe, 1971: 86, 119, pl. 17, figs 5, 6; Clark and Courtman-Stock, 1976: 122, 173; Cherbonnier and Guille, 1978: 169, pl. 10, figs 5, 6; Sloan *et al.*, 1979: 106, figs 11, 12; Clark, 1980: 535, 548; Tortonese, 1980: 124; Humpreys, 1981: 10, 24; James, 1982: 38, pl. 1D; Price, 1982: 8; Guille and Vadon, 1985: 63; Marsh, 1986: 71; Vine, 1986: 195; Sastry, 1991: 380, pl. 4, fig. 23; Liao and Clark, 1995: 261-262, fig. 140; Rowe and Gates, 1995: 387; Price and Rowe, 1996: 77; Rowe and Richmond, 2004: 3292; O'Hara *et al.*, 2004: 537-541; Benavides-Serrato and O'Hara, 2008: 51; Reza Fatemi *et al.*, 2010: 44, fig. 2; Olbers and Samyn, 2012: 145-146, pl. 3c, d; Mbongwa, 2013: 15.
Ophiocoma similanensis Bussarawit and Rowe, 1985: 1, figs 1, 2; Price and Rowe, 1996: 77.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D. up to 21.5mm, dorsal disc covered with coarse granules, ventral interradial area mostly naked with granules forming a V-shape. Radial shields not distinct. Oral shields variable, pear-shaped, circular or hexagonal, broadest distally. Adoral shields small, not contiguous. Dorsal arm plates uniform black, fan-shaped, distally convex, imbricating, more than twice as wide as long. Ventral arm plates uniform brown, from regular hexagons proximally to pentagons distally. Arm spines 3-4, uppermost largest, some specimens have longitudinal stripes on arm spines, spines flattened closest to disc. Tube feet in live specimens red, in preserved specimens white. Tentacle scales two, equal in size. Colour characteristically black, dark brown or dark red dorsally, lighter ventrally.

Distribution and habitat
Tropical to subtropical Indo-Pacific (Olbers and Samyn 2012), South Africa: Treasure Beach (KZN) to Kosi Bay (KZN); depth range: 0-27m.
Habitat: Associated with coral, found on gravel under boulders. Juveniles found on sponges (*Haliclona* species) or under dead coral boulders.

Remarks
Additional notes are given in Olbers and Samyn (2012) and even though *O. erinaceus* is one of the most abundant brittle stars in littoral tropical seas, its taxonomy has only recently been resolved. O'Hara *et al.* (2004) used molecular, morphological and day / night colour change data to show that *O. erinaceus* is a species complex of three species: *O. erinaceus*, *O. schoenleinii* Müller and Troschel, 1842 and *O. cynthiae* Benavides-Serrato and O'Hara, 2008.

In this study, distribution is extended from Treasure Beach (KZN) to Kosi Bay (KZN), (see Table 7.3).

The type material is in the Museum of Natural History at the University of Berlin (syntypes: ZMB Ech 921, ZMB Ech 922, ZMB Ech 923 and ZMB Ech 924) and the type locality is the Red Sea, depth unknown.

Figure 6.148. Distribution of *Ophiocoma erinaceus* in South Africa.

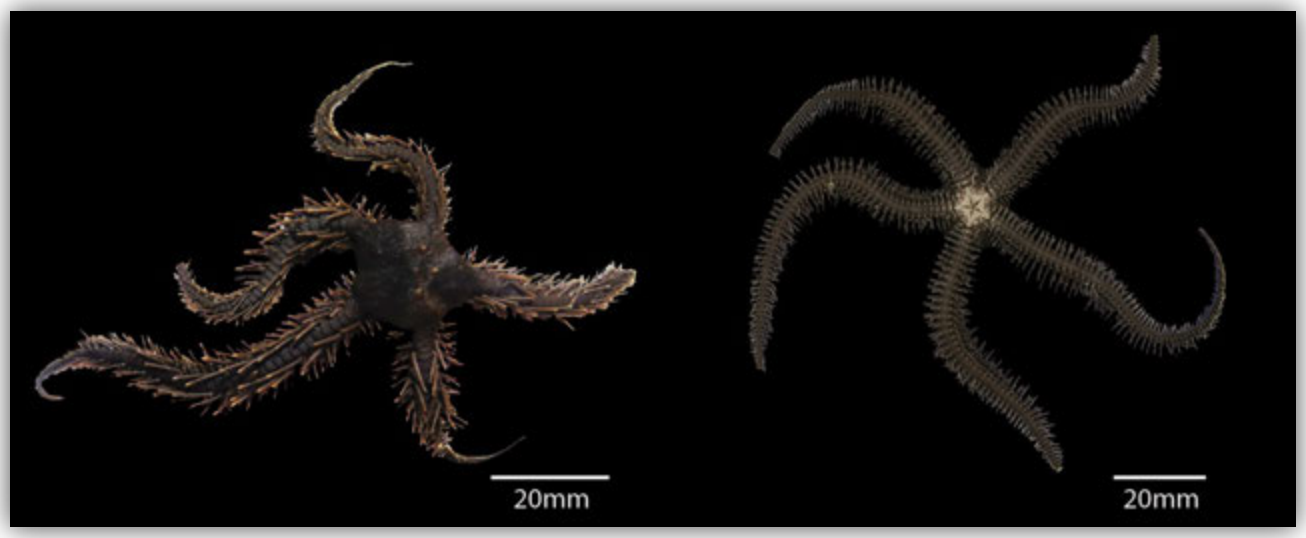

Figure 6.149. Dorsal (left) and ventral (right) views of *Ophiocoma erinaceus* (RBINS, RSAKZN/2016.008 (unaccessioned)).

Ophiocoma pica Müller and Troschel, 1842

Figs 6.150 and 6.151.

Ophiocoma pica Müller and Troschel, 1842: 101; Clark, 1921: 127, pl. 13, fig. 8; Clark, 1938: 333; Balinsky, 1957: 25-26; Macnae and Kalk, 1958: 130; Devaney, 1968: 131; Devaney, 1970: 19-20, figs 23-25, 27; Clark and Rowe, 1971: 86-87, 118; Clark and Courtman-Stock, 1976: 173; Cherbonnier and Guille, 1978: 172, pl. 11, figs 5, 6; Sloan *et al.*, 1979: 106, Clark, 1980: 535, 548; Tortonese, 1980: 124; Price, 1982: 8; James, 1982: 36-38, pl. 1C; Marsh, 1986: 71; Vine, 1986: 195; Sastry, 1991: 381, pl. 5, fig. 25; Liao and Clark, 1995: 262-263, fig. 141; Rowe and Gates, 1995: 387; Price and Rowe, 1996: 77; Olbers and Samyn, 2012: 146-147, pl. 3e, f.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D up to 17mm. Disc with spherical granules extending onto distal parts of ventral interradial areas. Radial shields not distinct. Oral shields usually oval. Adoral shields triangular, not contiguous. Oral papillae 3-4, dental papillae 6-10. Teeth one or two, slightly elongated and blunt. Genital slits long, genital papillae present, cone-shaped. Dorsal arm plates fan-shaped, convex on distal side with distal side being longer than proximal side, concave proximally. Ventral arm plates straight to slightly convex distally, plates becoming slightly longer distally. Arm spines five proximally, 4-5 distally, slender, first and second spines longest, *c.* twice segment length, lower arm spines same length as segment or slightly longer. Tentacle scales two, oval, large, inner one slightly smaller basally. Colour in life dark brown or black with radiating golden lines on disc and often, transverse bands annulating the arms.

Distribution and habitat
Indo-Pacific (Clark, 1921; Clark and Rowe, 1971), South Africa: Qolora (EC) to Kosi Bay (KZN); depth range: 0-24m.
Habitat: Under rocks or dead coral rubble.

Remarks
Additional notes on *O. pica* are given in Olbers and Samyn (2012). Distribution is here extended from Richards Bay (KZN) south to Qolora (EC), (see Table 7.3).

Location of type material is unknown. According to Müller and Troschel (1842) it is in the National Natural History Museum in Paris (MNHN), but this is denied by Nadia Améziane (pers. comm.). In addition, type locality is unknown, according to Müller and Troschel (1842).

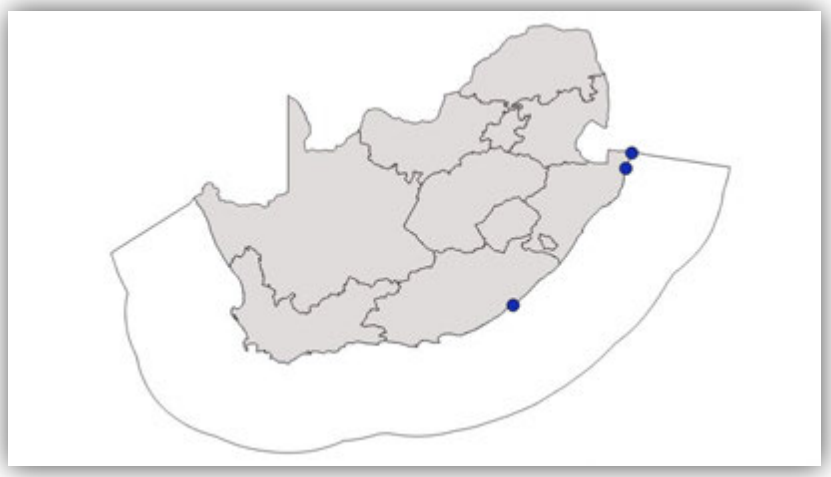

Figure 6.150. Distribution of *Ophiocoma pica* in South Africa.

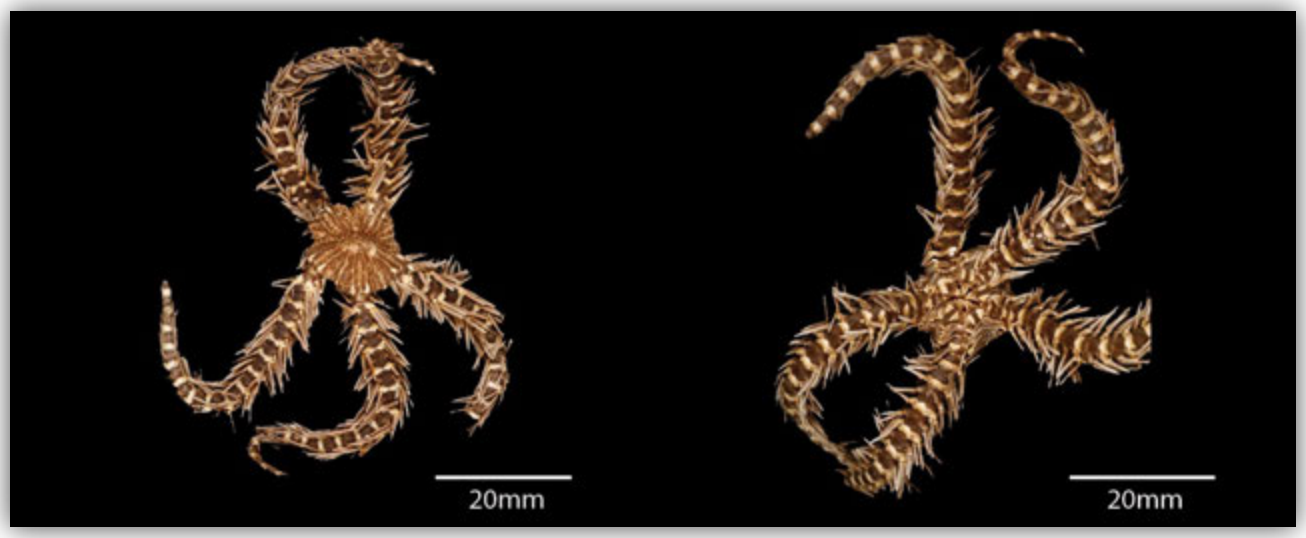

Figure 6.151. Dorsal (left) and ventral (right) views of *Ophiocoma pica* (RMCA MT1496).

***Ophiocoma pusilla* (Brock, 1888)**

Figs 6.152 and 6.153.

Ophiomastix pusilla Brock, 1888: 499; Devaney, 1970: 25.
Ophiocoma latilanxa Murakami, 1943a: 194-196, fig. 13; Murakami, 1943b: 218; Devaney, 1970: 25-27.
Ophiocoma pusilla: Clark, 1921: 131; Devaney, 1970: 25, figs 26, 29; Clark and Rowe, 1971: 86-87, 118; Clark and Courtman-Stock, 1976: 122, 174, fig. 190; Cherbonnier and Guille, 1978: 173-174, pl. 11, figs 3, 4; Sloan *et al.*, 1979: 106; Clark, 1980: 535, 544; Tortonese, 1980: 127; Humpreys, 1981: 10, 24; Price, 1982: 8; Guille and Vadon, 1985: 63; Marsh, 1986: 71; Vine, 1986: 195; Liao and Clark, 1995: 263-264, fig. 142; Rowe and Gates, 1995: 388; Price and Rowe, 1996: 77; Olbers and Samyn, 2012: 147-148, pl. 4a, b; Mbongwa, 2013: 15.

***Diagnosis** - adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D up to 8mm. Disc with uniformly distributed granules both dorsally and ventrally, concealing radial shields, granules forming a V-shape in interradial area. Oral shields oval, nearly twice as long as wide. Adoral shields triangular, not contiguous. Oral papillae 4-5. Dental papillae in 2-3 rows. Dorsal arm plates fan-shaped proximally, wider than long, with convex distal side contiguous, distally plates longer than wide and less contiguous. Ventral arm plates fan-shaped, wider than long, distally becoming longer than wide. Arm spines 4-5, hollow, glassy and *c.* two-and-a-half times segment length. Second

uppermost arm spines at a third of arm length with pustular distal expansions, while other arm spines tapering. Tentacle scales two. Colour in life, disc slightly speckled, may have banded arms from half way down the arms to the tips.

Distribution and habitat

Tropical Indo-West central Pacific Ocean (Rowe and Gates, 1995), including Red Sea and Mozambique (Clark, 1967; Clark and Courtman-Stock, 1976).
South Africa: Aliwal Shoal (KZN) to Kosi Bay (KZN); depth range: 0-32m.
Habitat: In sand channels, under rubble and associated with coral.

Remarks

Additional notes on *O. pusilla* are given by Olbers and Samyn (2012) who report this species as a new record for South Africa.

The type material is in the Museum of Natural History at the University of Berlin (ZMB Ech 5429 and ZMB Ech 4777), type locality is Ambon, Indonesia, depth unknown.

Figure 6.152. Distribution of *Ophiocoma pusilla* in South Africa.

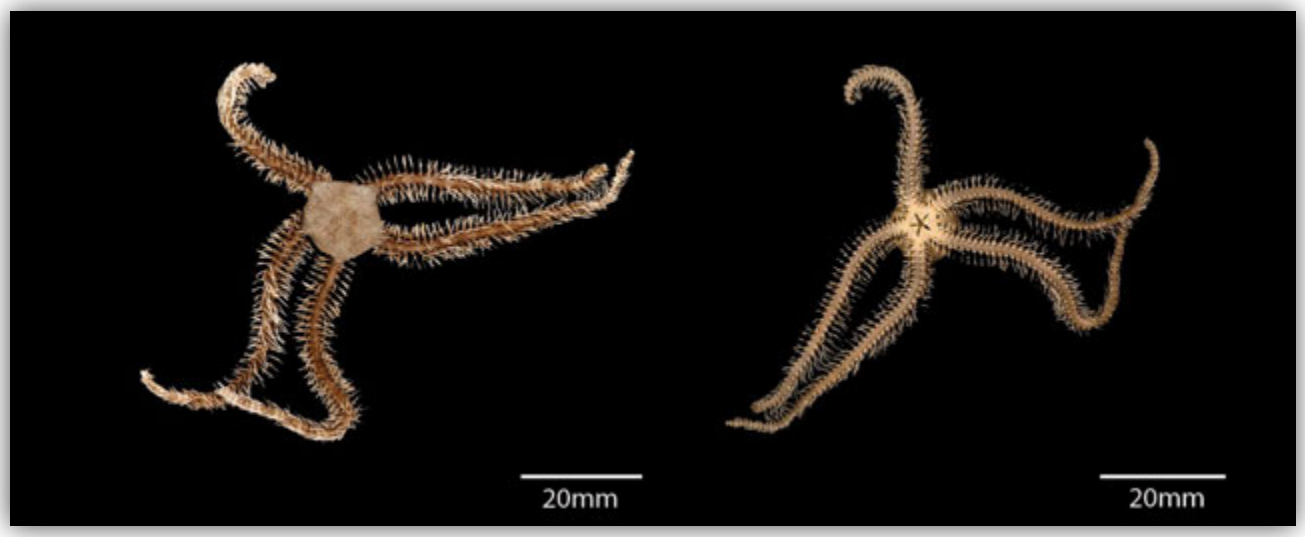

Figure 6.153. Dorsal (left) and ventral (right) views of *Ophiocoma pusilla* (RMCA MT2153).

***Ophiocoma scolopendrina* (Lamarck, 1816)**

Figs 6.154 and 6.155.

Ophiura scolopendrina Lamarck, 1816: 544.
Ophiocoma scolopendrina: Clark, 1932: 207; Kalk, 1958: 205; Macnae and Kalk, 1958: 130; Devaney, 1968: 203; Devaney, 1970: 33-35; Clark and Rowe, 1971: 86, 119, pl. 17, figs 3, 4; Clark and Courtman-Stock, 1976: 122, 174; Hughes and Gamble, 1977: 355; Sloan *et al.*, 1979: 106, fig. 13; Clark, 1980: 535; Tortonese, 1980: 124; Price, 1982: 8; James, 1982: 36-39, pl. 2A; Guille and Vadon, 1985: 63; Vine, 1986: 195; Marsh, 1986: 71; Sastry, 1991: 381, pl. 4, fig. 24; Liao and Clark, 1995: 264-265, fig. 143; Rowe and Gates, 1995: 388; Reza Fatemi *et al.*, 2010: 45, fig. 3; Olbers and Samyn, 2012: 148-150, pl. 4c, d; Mbongwa, 2013: 15-16.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D. up to 25mm. Disc round or pentagonal. Dorsal disc densely covered with spherical granules, covering the whole surface including the indistinct radial shields. Ventral disc with same, densely distributed granules, but less dense closer to genital slits. Oral shields oval, shorter than wide. Adoral shields restricted to the lateral edge of the oral shield, triangular, not contiguous. Oral papillae five, inner ones more pointed. Oral tentacle scale low and wide. Dental papillae 4-9, placed in a cluster below wide, truncated teeth. Genital slit bordered by elongated genital papillae. Dorsal arm plates fan-shaped, wider than long, distal margin straight in first segments, becoming convex in distal segments. First two ventral arm plates distinctly smaller, distal margin indented, lateral margins convex and proximal margin straight, *c.* as long as wide. Remaining ventral arm plates significantly larger, wider then long, distal margin convex, proximal margin concave. Arm spines 3-5, three on segment three, 4-5 on segment eight, uppermost ones thick, short, longer than segments; lower arm spines slender, longer than segment, except for first two segments. Tentacle scales two, oval, inner one a fraction longer. Colour in life, disc uniformly brown both dorsally and ventrally. Dorsal arm plates blotched with brown on beige, giving arms a variegated to banded pattern.

Distribution and habitat
Tropical Indo-Pacific (Rowe and Gates, 1995), including Red Sea (Clark and Rowe, 1971), South Africa: Umgazana (EC) to Kosi Bay (KZN); depth range: 0-179m.
Habitat: Common in the upper eulittoral zone and rocky shores.

Remarks
A detailed description of *O. scolopendrina* is given in Olbers and Samyn (2012), who also designated a neotype (MNHN EcOh 11043) for *O. scolopendrina,* locality Mauritius. In this study, distribution is extended from KwaZulu-Natal south to Umgazana (EC), (see Table 7.3).

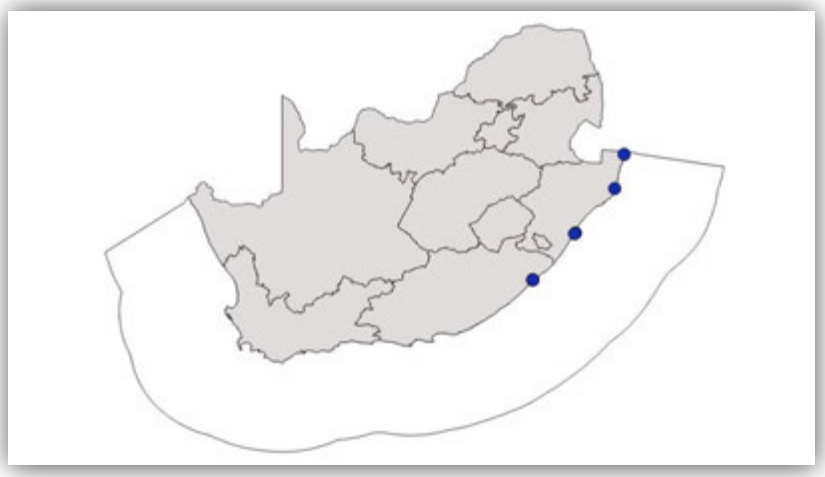

Figure 6.154. Distribution of *Ophiocoma scolopendrina* in South Africa

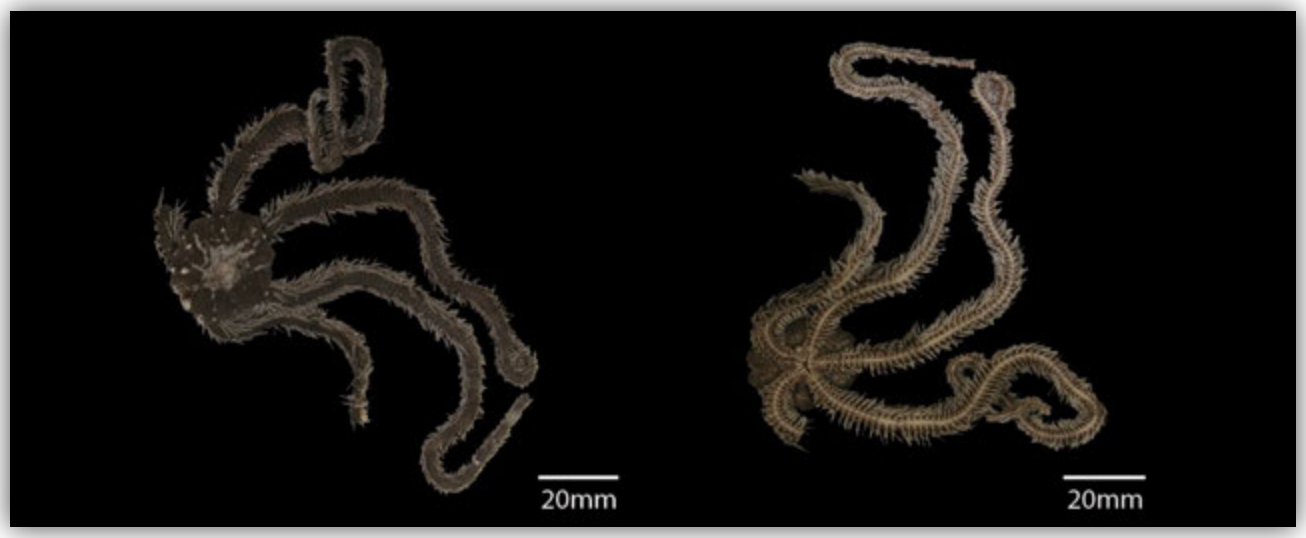

Figure 6.155. Dorsal (left) and ventral (right) views of *Ophiocoma scolopendrina* (RMCA MT1708).

***Ophiocoma valenciae* Müller and Troschel, 1842**

Figs 6.156 and 6.157.

Ophiocoma valenciae Müller and Troschel, 1842: 102; Eyre and Stephenson, 1938: 38, 43; Kalk, 1958: 200, 207, 237; Macnae and Kalk, 1958: 130; Clark, 1967: 44-45; Devaney, 1968: 126; Macnae and Kalk, 1969: 101, 106, 130; Clark and Rowe, 1971: 86, 119, pl. 18, fig. 1; Hughes and Gamble, 1977: 355; Sloan *et al.*, 1979: 109, fig. 14; Clark, 1980: 535, 548; Tortonese, 1980: 125; Humpreys, 1981: 10, 24-25; Price, 1982: 8; Vine, 1986: 195; Olbers and Samyn, 2012: 150, pl. 4e, f; Sastry, 1991: 382; Milne, 2012: 155; Mbongwa, 2013: 16.

Diagnosis *- adapted from Devaney (1970) and Olbers and Samyn (2012).*
D.D. up to 20mm. Disc covered dorsally and ventrally with moderately fine granules, which become elongated towards margin of disc. Radial shields defined by lighter colour on some specimens, but this could be an artefact of preservation. Oral shields round to oval. Adoral shields not contiguous. Oral papillae 3-4, dental papillae numerous. Teeth square 3-4. Genital slits long, genital papillae present. Dorsal arm plates broad, oval, broadly contiguous. Ventral arm plates square to pentagonal, distal edge straight, proximal edge may be slightly convex. Arm spines up to six, uppermost spines shorter than middle spines, one segment length. Tentacle scale one, oval, sometimes two on first segments. Colour in life, disc brown, arms tawny with darker bands.

Distribution and habitat
Tropical Indian Ocean, including Red Sea and possibly Persian Gulf (Clark and Rowe, 1971; Tortonese, 1980), South Africa: Umgazana (EC) to Kosi Bay (KZN); depth range: 0-18m.
Habitat: Associated with coral and sponges, found within rocky crevices, cobbles, rubble and various algal beds.

Remarks
Additional notes of *O. valenciae* are given in Olbers and Samyn (2012).

The type material is in the Museum of Natural History at the University of Berlin (syntypes ZMB Ech 4625 and ZMB Ech 955) and the type locality is the Gulf of Aden, depth unknown.

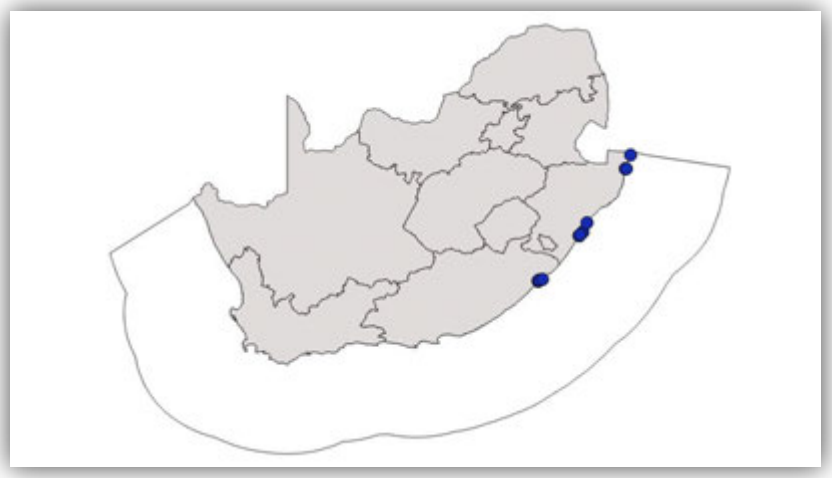

Figure 6.156. Distribution of *Ophiocoma valenciae* in South Africa.

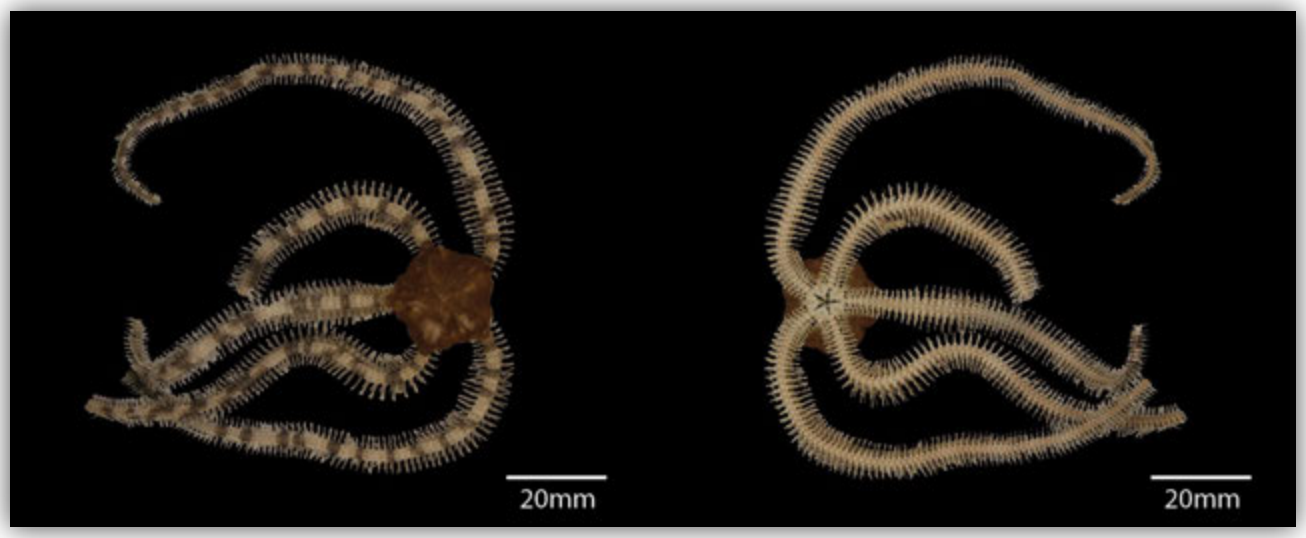

Figure 6.157. Dorsal (left) and ventral (right) views of *Ophiocoma valenciae* (RMCA MT1750).

Genus Ophiocomella A.H. Clark, 1939

Diagnosis *- adapted from Clark, A.H. (1939).*
Small, disc up to 6mm. Disc with fine scales, bearing numerous scattered stout spines, blunt. Radial shields small, widely separated. Arm spines 4-5, spines may be equal in length or subequal with uppermost longest and lowermost shortest. Tentacle scales two on first tentacle pore and then one for remainder of arm.

Ophiocomella sexradia (Duncan, 1887)

Figs 6.158 and 6.159.

Ophiocnida sexradia Duncan, 1887: 92-93, pl. 8, figs 10, 11; Koehler, 1905a: 33.
Ophiocoma parva Clark, 1915a: 292, pl. 14, figs 8, 9; Clark, 1921: 132, pl. 13, fig. 4; Clark, 1938: 331-332; Clark, A.H., 1939: 5-7, pl. 1, figs 1, 2; Clark, 1946: 247; Balinsky, 1957: 27; Kalk, 1958: 207, 216, 237; Macnae and Kalk, 1969: 104, 106, 130; Clark and Rowe, 1971: 86, 87, 118, fig. 38d, pl. 18, fig. 6.
Amphilimna sexradia: Clark, 1915a: 259.
Amphilimna sexradiata: Koehler, 1927: 3.
Ophiocomella schultzi Clark, 1941: 481-483; Clark and Rowe, 1971, fig. 38c, e.
Ophiocomella clippertoni: Clark, A.H., 1952: 296.
Ophiomastix sexradiata Clark, A.H., 1952: 297-298; Clark and Rowe, 1971: 86, 118, fig. 38a, b.

Ophiocomella sexradia: Clark and Rowe, 1971: 86-87, 118, fig. 38c-f; Devaney, 1974: 162-164; Clark and Courtman-Stock, 1976: 105, 122, 175; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 178-179, pl. 12, figs 5, 6; Sloan *et al.*, 1979: 109; Marsh, 1986: 71; Vine, 1986: 195; Sastry, 1991: 374, 382, pl. 4, fig. 20; Liao and Clark, 1995: 265, fig. 144; Rowe and Gates, 1995: 389; Richmond, 2002: 326; Putchakarn and Sonchaeng, 2004: 423; Stöhr *et al.*, 2008: 547, 555-556; Mbongwa, 2013: 16; Olbers *et al.*, 2015: 95-96, pl. 3E, F.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 6mm. Disc covered with short, blunt spines, densities may differ. Radial shields not distinct. Oral shields variable, round, rhombic, spearhead-shaped or hexagonal. Adoral shields not contiguous. Dental papillae 4-6, usually in series. Oral papillae three. Teeth blunt and wide. Genital slits narrow and elongated. Arms six, rarely three or seven. Dorsal arm plates fan-shaped, as wide as long. Ventral arm plates squarish, distal edge rounded, proximal edge truncated. Arm spines up to four, sometimes five, tapering to blunt tips or may be square-tipped, one segment length. Tentacle scale one, oval, first pair of pores may have two. Fissiparous. Colour in life, disc dark brownish or green, arms banded with brown, green or red.

Distribution and habitat
Mozambique, Reunion, Rodrigues, India, China, south Japan, Australia, Tasman Sea, Hawaiian Islands (Clark and Rowe, 1971; Sastry, 1991; Rowe and Gates, 1995; Richmond, 2002; Rowe and Richmond, 2004), South Africa: Isipingo (KZN); depth range: 0-33m.
Habitat: Associated with sponges, coral bases and sea grass beds or algae.

Remarks
In KwaZulu-Natal, this species appears to be associated with the six-armed species *Ophiactis savignyi* found in and among rocky shore algae scrapings. The type material is housed in the Museum of Comparative Zoology (holotype: MCZ OPH-3758, paratype: MCZ OPH-3759 and MCZ OPH-3855), type locality Torres Strait, Murray Island, Australia, depth unknown.

Figure 6.158. Distribution of *Ophiocomella sexradia* in South Africa.

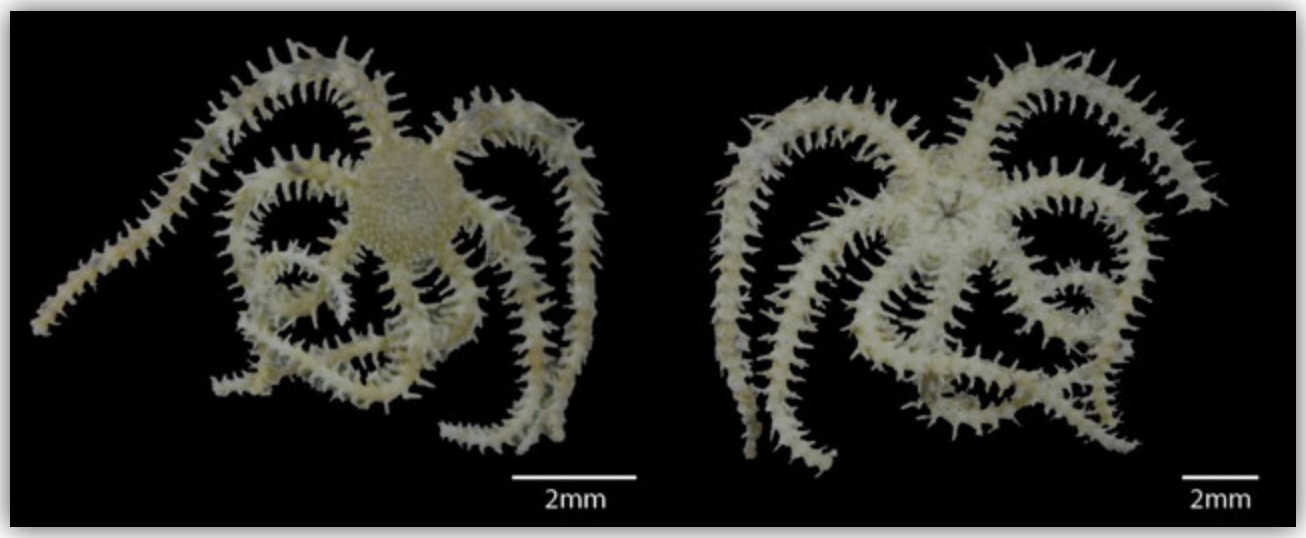

Figure 6.159. Dorsal (left) and ventral (right) views of *Ophiocomella sexradia* (EKZNW RR_4_JMO_2010).

Genus Ophiomastix Müller and Troschel, 1842

Diagnosis - *adapted from Lyman (1882) and Clark and Courtman-Stock (1976).*
Disc mostly smooth, or with scattered spinelets or granules, densities differ. Radial shields indistinct, but proportionally larger than in *Ophiocoma*. Oral and dental papillae as in *Ophiocoma*. Adoral shields small and widely separated. Arm spines smooth, solid, up to four, uppermost usually club-shaped or tips clavate. Genital slits usually long, starting close to oral shield. Tentacle scales one or two.

Ophiomastix koehleri Devaney, 1977

Figs 6.160 and 6.161.

Ophiomastix koehleri Devaney, 1977: 274-283, figs 1-4; Cherbonnier and Guille, 1978: 186-188, pl.11, figs 1, 2; Sloan *et al.*, 1979: 92, 109, fig.16; Humpreys, 1981: 10, 25; Olbers *et al.*, 2015: 96, pl. 4A, B.

Diagnosis - *adapted from Devaney (1977) and Cherbonnier and Guille (1978).*
D.D. up to 25mm. Disc round and puffy, dorsally disc covered uniformly by short, rounded granules, disc ventrally with similar granules, but not extending up to oral shields, leaving a broken wide V-shaped interradial area with scales dark brown, variegated with whitish grey. Oral shields round with dark patch on each surrounded by white on margin, adoral shields small, not contiguous. Genital slits large, almost reaching disc margin, genital papillae present, extending to oral shields. Dorsal arm plates fan-shaped, much wider than long, convex distally, most often a thin white line bordering the plates, narrowly contiguous. Ventral arm plates fan-shaped with convex distal edges, brown with small grey patch surrounded by white margin. Arm spines 3-4 on each side of same or mostly adjacent segments, often alternating. Uppermost spine markedly longer, cigar-shaped, clavate distally and more or less bifurcate at tip, broadly banded, with bands becoming more obvious distally, up to five times segment length. Remaining spines cigar-shaped with blunt tips, greyish bands not always around full circumference of spine, 2-3 times segment length, shortest being one-and-a-half times segment length. Tentacle scales two, becoming one after *c.* one-third of arm length, oval, similar in size. Colour in life uniformly dark purple, brown, black with white edges, dorsal arm plates off-white with large, irregular purple patches, giving arms banded appearance. Upper arm spines pale or purple mottled, clavate, remaining arm spines purple and white annulations, tentacle scales banded, oral shields with large dark purple blotches.

Distribution and habitat
Madagascar, Zanzibar, Kenya, Comoros, Aldabra (Cherbonnier and Guille, 1978), South Africa: Aliwal Shoal (KZN) to Sodwana Bay (KZN); depth range: 0-18m.
Habitat: Under *Porites* coral colonies and in lagoonal seagrass beds.

Remarks
According to Devaney (1977) the type locality is Zanzibar and the holotype is in the Natural History Museum in London (NHMUK 1965.6.1.451). Olbers *et al.* (2015) reported this species as a new record for South Africa and provide additional remarks.

Figure 6.160. Distribution of *Ophiomastix koehleri* in South Africa.

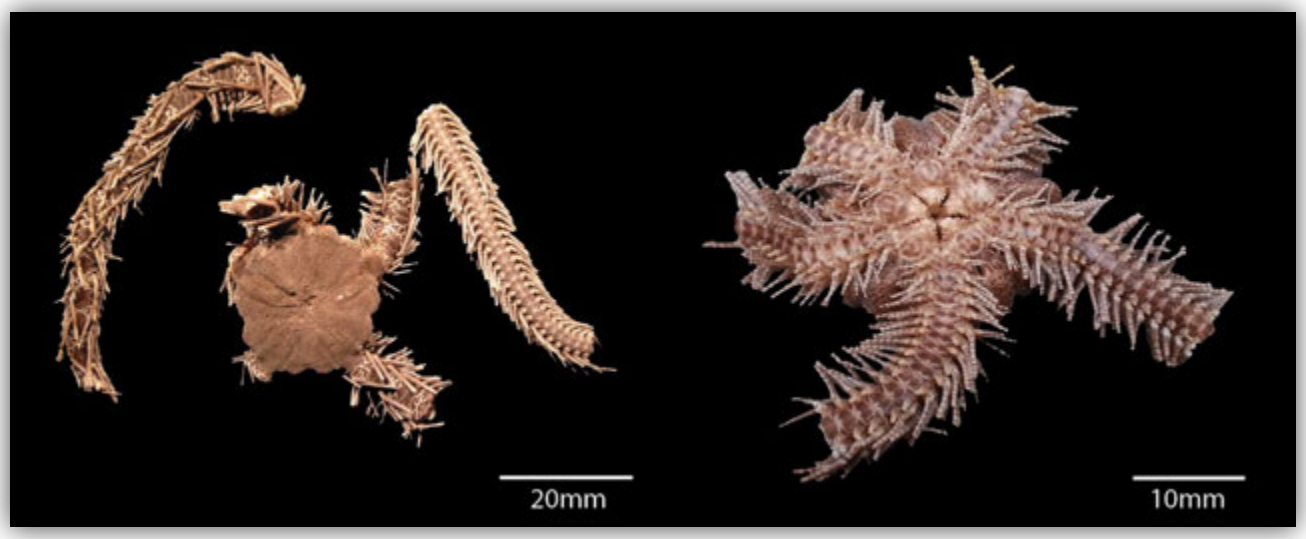

Figure 6.161. Dorsal (left) and ventral (right) views of *Ophiomastix koehleri* (SAMC A28130).

Ophiomastix venosa Peters, 1851
Figs 6.162 and 6.163.

Ophiomastix venosa Peters, 1851: 464-465; Lütken, 1869: 44; Lyman, 1882: 175; Koehler, 1904b: 73-74, figs 28, 29; Clark, 1915a: 296; Clark, 1921: 134, 138; Clark, 1923: 349; Balinsky, 1957: 27-28; Kalk, 1958: 237; Macnae and Kalk, 1969: 130; Clark and Rowe, 1971: 88, 120; Clark and Courtman-Stock, 1976: 105, 122, 176-177, fig. 191; Devaney, 1978: 279, 350-353, figs 41, 42; Cherbonnier and Guille, 1978: 190-192, fig. 63, pl. 14, figs 1, 2;

Sloan *et al.*, 1979: 109-111; Tortonese, 1980: 117, 128, fig. 12; Humpreys, 1981: 10, 25; Olbers *et al.*, 2015: 96, 98, pl. 4C, D.

Diagnosis *- adapted from Clark and Courtman-Stock (1976), Devaney (1978) and Cherbonnier and Guille (1978).*

D.D. up to 36mm. Disc round and puffy, dorsal disc scales fine, light brown, pair of radiating dark brown lines outlined in white starting from base of each arm and meandering in random pattern. Ventral disc scales lighter brown and coarser in proximal interradial areas, some ovate imbricated scales delimiting periphery of disc. Granules sparsely scattered on both dorsal and ventral sides of disc, with scattered cylindrical spines towards margin of dorsal disc. Radial shields visible, but not distinct. Genital slits large, reaching disc margin, genital papillae absent. Oral shields slightly wider than long, adoral shields triangular, not contiguous. Arm spines 2-4, alternating in number, cigar-shaped, but tapering with darker longitudinal line, on every 2-3 segments, upper arm spine enlarged with clavate, cloven or digitate tip, *c.* 3.5 - 4 times segment length, longitudinal line absent on largest spines, other arm spines *c.* twice segment length. Dorsal arm plates broad fan-shaped, wider than long, broadly contiguous, becoming slightly longer than wide, narrowly contiguous. Ventral arm plates pentagonal but truncated, distal side straight or convex, lateral sides may be concave. Tentacle scales two basally, distally one, ovate. Colour in life, disc light brown with radiating lines on disc, radial shields with black petaloid pattern, arm spines with longitudinal dark stripe, dorsal arm plates brownish with a darker faded line down length of arm, ventrally uniformly light brown.

Distribution and habitat

Mozambique, Tanzania, Kenya, Somalia, Mascarene Basin, Madagascar, Rodriguez, Comoros, Aldabra, Seychelles, Bay of Bengal, Philippines (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Devaney, 1978; Tortonese, 1980), South Africa: Coffee Bay (EC) to Sodwana Bay (KZN); depth range: 0-21m.

Habitat: Shallow lagoons, often on sand and rubble, algal carpet, under boulders, coral heads, and *Porites* in lagoonal seagrass beds, may be in same habitat with *Ophiocoma scolopendrina.*

Remarks

Type locality is Mozambique, syntypes are in the Museum of Natural History at the University of Berlin (ZMB Ech 965, ZMB Ech 977, ZMB Ech 978 and ZMB Ech 979), depth unknown.

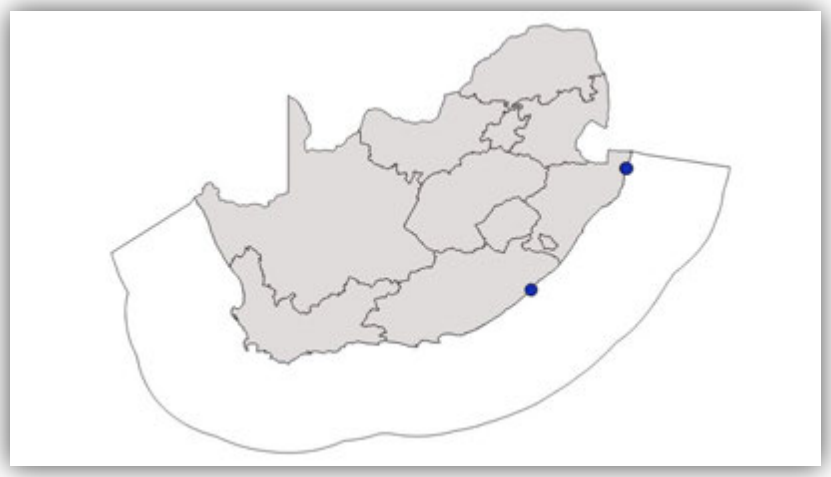

Figure 6.162. Distribution of *Ophiomastix venosa* in South Africa.

Figure 6.163. Dorsal (left) and ventral (right) views of *Ophiomastix venosa* (RMCA MT2353).

Genus *Ophiopsila* Forbes, 1843

Diagnosis - *adapted from Clark and Courtman-Stock (1976).*
Moderate size, disc with fine scales, radial shields distinct, bar-like. Oral shields rhombic with rounded angles or spearhead-shaped, proximal lobe may be truncated. Oral papillae 2-3, rounded or spiniform, separated from apical tooth by diastema in which the first oral tentacle scale can be seen. Dental papillae 3-7. Dorsal arm plates fan-shaped or hexagonal. Ventral arm plates pentagonal with rounded angles distally, may be contiguous. Arm spines numerous, about ten, flattened, lowermost longest, middle shortest. Tentacle scales two, inner one placed on ventral arm plate, long, sword-like and lying obliquely across ventral arm plate, outer scale short, papilliform or spiniform.

Martynov (2010) proposed moving *Ophiopsila* to the Amphiuridae based on a number of internal structures. This proposal would require further investigation and for the purposes of this report, *Ophiopsila* is retained in the Ophiocomidae.

Ophiopsila bispinosa Clark, 1974

Fig. 6.164 and 6.165.

Ophiopsila bispinosa Clark, 1974: 472-475, fig. 13; Clark and Courtman-Stock, 1976: 105, 122, 177, figs 185, 188.

Diagnosis - *adapted from Clark (1974).*
D.D. up to 10mm, D.D./A.L = 1/5. Arms 5-6. Disc round and puffy. Dorsal disc scales fine. Radial shields distinct, length two-thirds disc radius, narrow, not contiguous. Oral shields large, tumid, spearhead-shaped, with distal lobe longer than wide. Adoral shields usually contiguous, with distal lobe between oral shield and first lateral arm plate. Dental papillae 3-5 at apex, some have typical amphiurid-like pair with gap separating them. Oral papillae 2-3, spiniform, slightly flattened, separated from apical tooth by diastema in which the first oral tentacle scale can be seen, this being spiniform. Dorsal arm plates not distinct, equally wide as long, becoming fan-shaped, contiguous for less than half their breadth, longitudinal ridge running down arm. Ventral arm plates proximally wider than long, with middle of distal edge concave, becoming longer than wide and not contiguous distally. Arm spines up to ten, flattened, paddle-like, equal or just more than one segment length, lowest arm spine

spiniform, narrow and sharp. Genital slits large, genital papillae absent. Tentacle scales two, inner one placed on ventral arm plate, long, sword-like and lying obliquely across ventral arm plate after second or third segment, outer tentacle scale short, less than half innermost scale.

Distribution and habitat

South Africa: Tongaat (KZN) to off Umhlali (KZN); depth range: 38-150m.
Habitat: Mud, coarse sand and coral.

Remarks

Endemic to South Africa (see Table 7.4). Type material is in Iziko South African Museum (holotype: SAMC A22793; paratype: SAMC A22794; examined) and the type locality is off the Tugela River mouth, depth 138m.

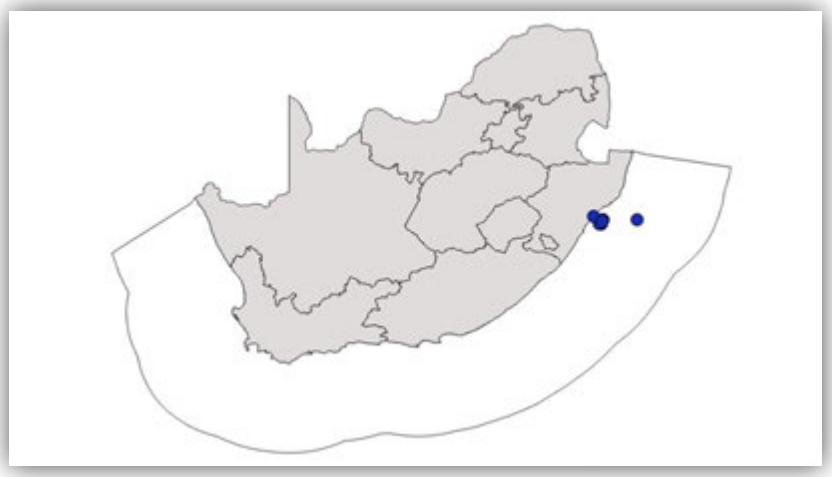

Figure 6.164. Distribution of *Ophiopsila bispinosa* in South Africa.

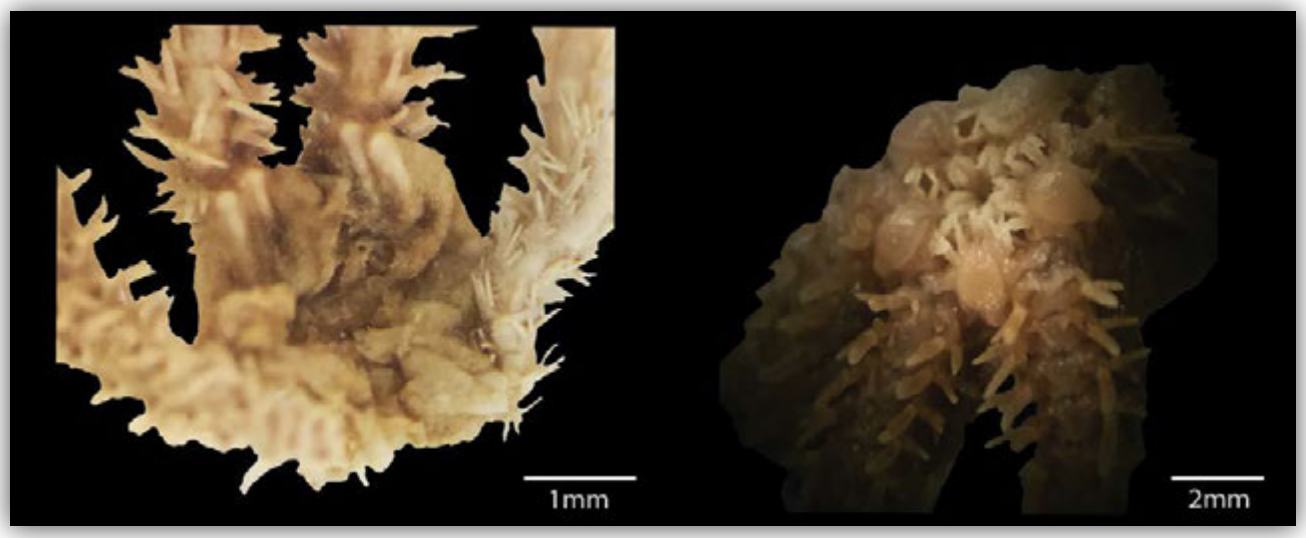

Figure 165. Dorsal (left) and ventral (right) views of *Ophiopsila bispinosa,* SAMC A22794 (dorsal); SAMC A22793 (ventral).

Ophiopsila seminuda Clark, 1952

Figs 6.166 and 6.167.

Ophiopsila seminuda Clark, A.M., 1952: 200, 218-219, fig. 3a, b; Day *et al.*, 1970: 81; Clark, 1974: 470-472, fig. 12; Clark and Courtman-Stock, 1976: 105, 122, 178, figs 184, 187.

Diagnosis *- adapted from Clark, A.M. (1952).*

D.D. up to 8mm, disc round. Dorsal disc scales fine, slightly larger around radial shields. Radial shields moderately distinct, long, narrow, not contiguous, separated by two rows of scales, length about one-third disc radius. Oral shields round, rhombic or hexagonal, either as wide as long or wider than long. Adoral shields may or may not be contiguous, outwardly extended, separating oral shield and lateral arm shield. Oral papillae two, broad, flat and blunt, appear similar to those of an amphiurid. Dental papillae up to seven. Teeth 4-5, in series. Second oral tentacle scale smaller than oral papillae. Dorsal arm plates not distinct, hexagonal or oval, much longer than wide basally, becoming slightly wider than long. Ventral arm plates slightly longer than wide, pentagonal, truncated, distal edge slightly concave. Arm spines up to ten, spatulate, broad round tips, lowermost spines largest in length and thickness, uppermost half segment length, lowermost twice segment length. Genital slits wide and large, genital papillae absent. Tentacle scales two, outer one relatively short and blunt, inner one long, blunt, not tapering.

Distribution and habitat

Reunion, South Africa: Cape Town (WC) to Tugela River mouth (KZN), depth range: 9-182m.
Habitat: Mud, sand, shell, limestone reef, shingle and gravel.

Remarks

Apart from the geographical distinction between *Ophiopsila seminuda* and *O. bispinosa*, *O. bispinosa* has i) finer disc scaling; ii) a spiniform distal oral papillae; iii) more pointed arm spines and iv) a spiniform second tentacle scale.

Clark and Courtman-Stock (1976) reported the lowermost arm spines being half segment length, contradicting the original description, which reads “the lowest is much the largest, both in thickness and in length, being nearly twice in length of a segment, while uppermost is only half as long”. The latter here is confirmed.

Only one other *O. seminuda* specimen has been found outside South Africa (MNHN-IE-2012-1353). Found off Reunion (-20.9916°S; 55.2516°E), on 27 August 1982 at a depth of 58-70m the RV *Marion Dufresne*.

The location of the type material is unknown, type locality False Bay, South Africa, depth 27-28m.

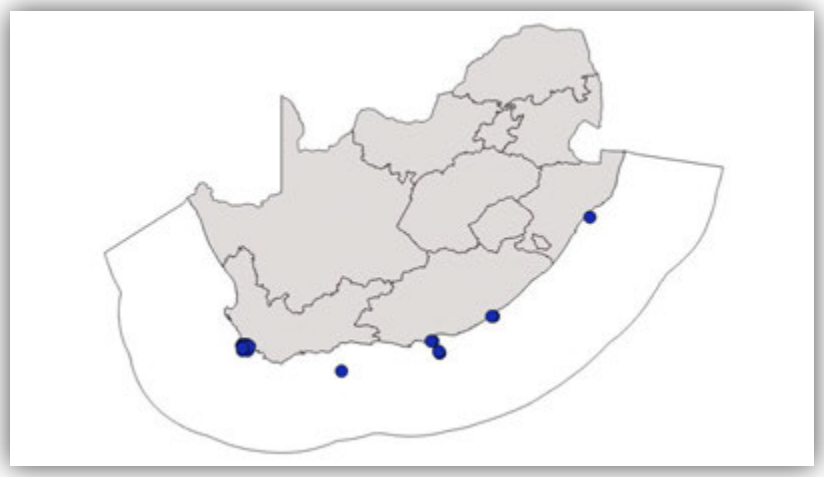

Figure 6.166. Distribution of *Ophiopsila seminuda* in South Africa.

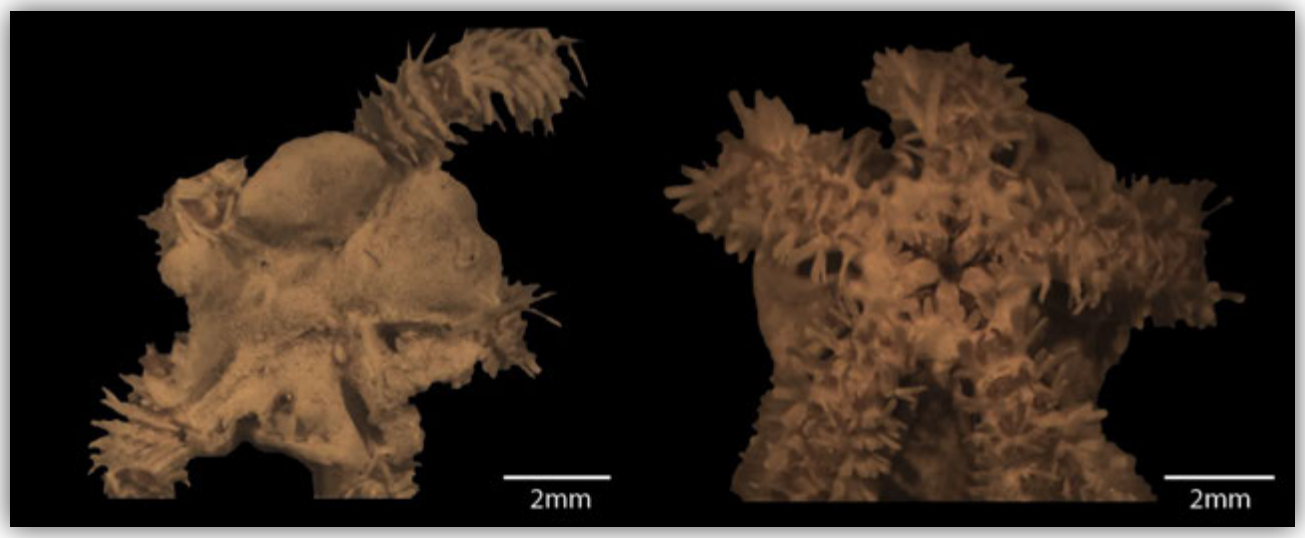

Figure 6.167. Dorsal (left) and ventral (right) views of *Ophiopsila seminuda* (SAMC A084230).

Family OPHIONEREIDIDAE Ljungman, 1867

Diagnosis *- adapted from Matsumoto (1917) and Clark and Courtman-Stock (1976).*
Disc large, flat, no granules or spines, but with distinct scales. Arms moderately long, stout, widen at some distance from disc base, arms inserted ventrally below disc. Arm spines long, erect. Radial shields small to medium, more or less widely separated. Oral shields usually spearhead-shaped. Adoral shields may be narrowly contiguous or not. Teeth broad quadrangular or with blunt apex. Oral papillae four or more. Dorsal and ventral arm plates well-developed. Tentacle scale single.

Genus Ophionereis **Lütken, 1859**

Diagnosis *- adapted from Clark (1953) and Clark and Courtman-Stock (1976).*
Characteristics as for family and distinguished by presence of a pair of supplementary dorsal arm plates.

Ophionereis australis (Clark, 1923)

Figs 6.168 and 6.169.

Ophiochiton australis Clark, 1923: 345-347, fig. 3, pl. 20, figs 1, 2.
Ophionereis australis: Mortensen, 1933c: 374-375, fig. 77; Clark and Courtman-Stock, 1976: 106, 124, 179, fig. 195; Clark 1953: 66, 67; Balinsky, 1957: 24; Kalk, 1958: 207; Rowe and Gates, 1995: 407; Macnae and Kalk, 1969: 130.

Diagnosis *- adapted from Clark (1923).*

D.D. up to 11mm. Disc pentagonal, fully scaled, scales coarse, distinct with radiating pattern dorsally. Radial shields small, widely separated, oval to pear-shaped, distinct. Oral shields oval to spearhead-shaped, longer than wide, adoral shields distinct, not contiguous. Oral papillae four, distalmost broad, remaining three elliptical leaf-shaped. Teeth broad. Dental papillae absent. Genital slits entire interradial length, genital papillae bordering proximal ends of slits. Dorsal arm plates broad fan-shaped, wider than long, convex, being in contact for at least half of width of proximal margin, bordered by distinct triangular supplementary dorsal arm plates, *c.* no less than half-length of dorsal arm plate. Ventral arm plates fan-shaped, widest distally, distal side convex, longer than wide. Arm spines three, thick, short, blunt, erect, equal in size, just shorter than segment length. Tentacle scale single, oval and large. Colour in life light brown, slightly lighter on ventral side, radial shields whitish with darker brown margin, making them distinct.

Distribution and habitat

Mozambique and Australia (Clark and Courtman-Stock, 1976; Rowe and Gates, 1995), South Africa: Amanzimtoti (KZN) to Sodwana Bay (KZN); depth range: 0-205m.
Habitat: Shell, rock, sand, gravelly bottom with worm tubes.

Remarks

In the original description, Clark noted “a complete absence of supplementary upper arm plates” but his drawing clearly shows these supplementary plates, especially in the first couple of free segments. Mortensen (1933c) was the first to note Clark’s error, and in addition, the dorsal supplementary plates were only clear on the first 5-6 segments, becoming smaller distally on larger specimens and in specimens with a disc diameter of 5-6mm. Based on these three characteristics, this species was moved from *Ophiochiton* to *Ophionereis* by Mortensen (1933c).

The type material is in the Iziko South African Museum (holotype: SAMC A6439; examined) and the Museum of Comparative Zoology (paratype: MCZ OPH-4357), with the type locality being off the Tugela River mouth, depth 86m.

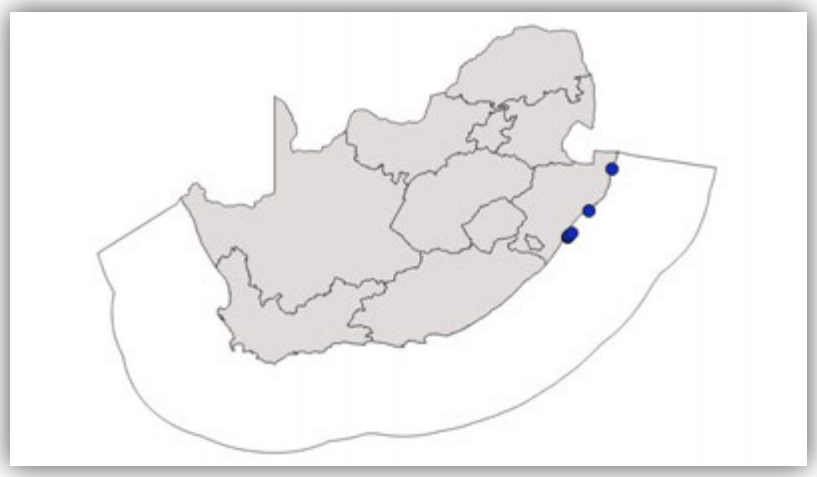

Figure 6.168. Distribution of *Ophionereis australis* in South Africa.

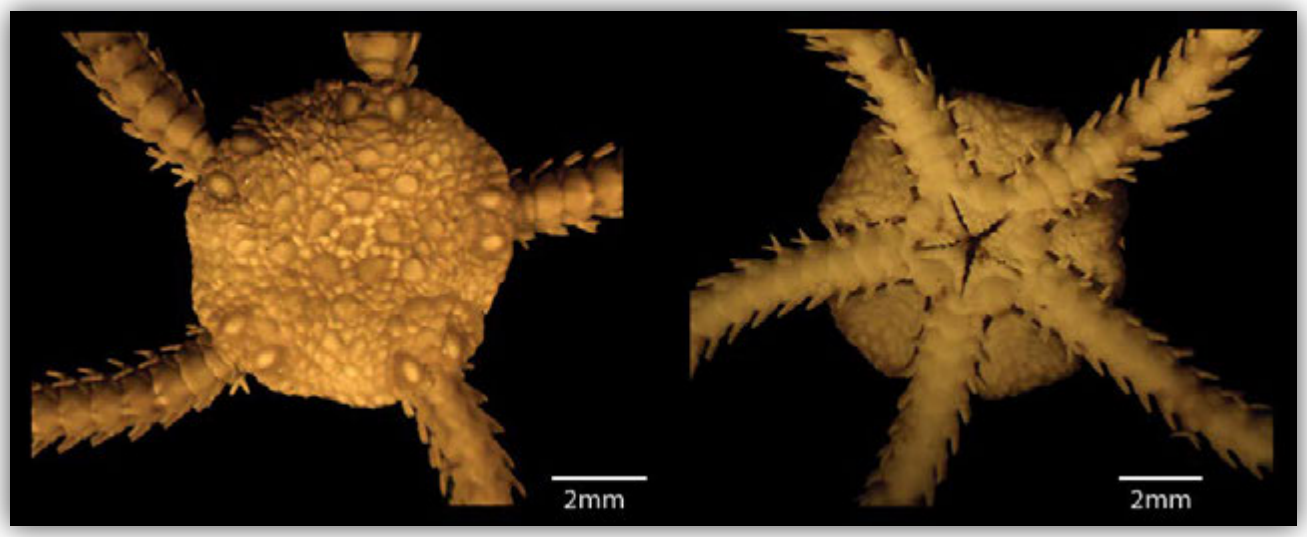

Figure 6.169. Dorsal (left) and ventral (right) views of *Ophionereis australis* (SAMC A088277).

Ophionereis dubia dubia **(Müller and Troschel, 1842)**

Figs 6.170 and 6.171.

Ophiolepis dubia Müller and Troschel, 1842: 94; Day *et al.*, 1970: 81.
Ophionereis dubia: Lyman, 1865: 146; Ljungman, 1867b: 310; Duncan, 1879: 448, 480; Lyman, 1882: 161, 286, 299, 311, 325; Bell, 1909: 19; Clark, 1915a: 289; Clark, 1923: 343-344; Burfield, 1924: 152; Mortensen, 1933c: 374; Stephenson *et al.*, 1937: 380; Clark, 1946: 239-240; Clark, 1953: 83-88, figs 9, 10; Day *et al.*, 1970: 81; Clark and Rowe, 1971: 122; Clark and Courtman-Stock, 1976: 106, 124, 179-180, fig. 193; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 203-205, figs 67a-f; Irimura, 1979: 5; Humpreys, 1981: 10, 25; Irimura, 1981: 46; Price, 1981: 7, 10; Irimura, 1982: 71-72, fig. 43, pl. 2, fig. 6, pl. 13, fig. 1; Guille and Vadon, 1985: 63; Vine, 1986: 195; Rowe and Gates, 1995: 408; Price and Rowe, 1996: 77; Marsh and Morrison, 2004: 296; Putchakarn and Sonchaeng, 2004: 423; Milne, 2012: 155.
Ophionereis dubia sinensis Duncan, 1879: 464.
Ophiocrasis dictydisca Clark, 1911: 175-177, fig. 179.
Ophiocrasis marktanneri Matsumoto, 1915: 90-91.
Ophionereis stigma Clark, 1938: 325-327; Clark, 1946: 237, 239.
Ophionereis dubia dubia: Liao and Clark, 1995: 274-275, fig. 151.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 9mm. Disc round, smooth, scales very fine, no armament. Characteristic 'V' or 'Y' at base of radial shields. Disc scaling moderately fine, continuing off disc onto first dorsal arm plates, ventral scaling complete to jaws. Radial shields small, fairly narrow or oval and well-separated. Oral shields large, spearhead-shaped or oval, longer than wide. Adoral shields wide-triangular, moderate in size, not contiguous. Oral papillae 4-5, distalmost papillae being widest. Teeth lowermost rounded, others square. Genital slits reach disc margin, no genital papillae, genital plates slightly enlarged. Arms long and slender, banded approximately every 3-5 segments. Dorsal arm plates trapezoid, distal edge rounded, as wide as long. Supplementary dorsal arm plates triangular, length of dorsal arm plate becoming smaller distally. Ventral arm plates rhombic or square, distal edge straight or somewhat convex, distally becoming pentagonal. Arm spines three, thick, stout, somewhat appressed to arms, same length as segment, single light brown band, uppermost spine slightly shorter with middle spine longest, tapering to blunt points. Tentacle scale single, oval. Colour in life pale yellow or greyish yellow green with reddish or dark brown reticulation on dorsal disc, arms banded dorsally only, reddish purple, brown or yellow.

Distribution and habitat
Red Sea, Persian Gulf, west India, Pakistan, Maldive area, Ceylon, Bay of Bengal, East Indies, China, south Japan, Philippines and Australia (Burfield, 1924; Clark and Rowe, 1971; Tortonese, 1980; Liao and Clark, 1995; Rowe and Gates, 1995; Richmond, 2002), South Africa: Elands Bay (WC) to Bhanga Nek (KZN); depth range: 0-230m.
Habitat: Sand, shell, white mud, coral rubble and rock.

Remarks
Distribution range was extended both west and east within South Africa (see Table 7.3). The type material whereabouts is undetermined and the type locality is the Red Sea.

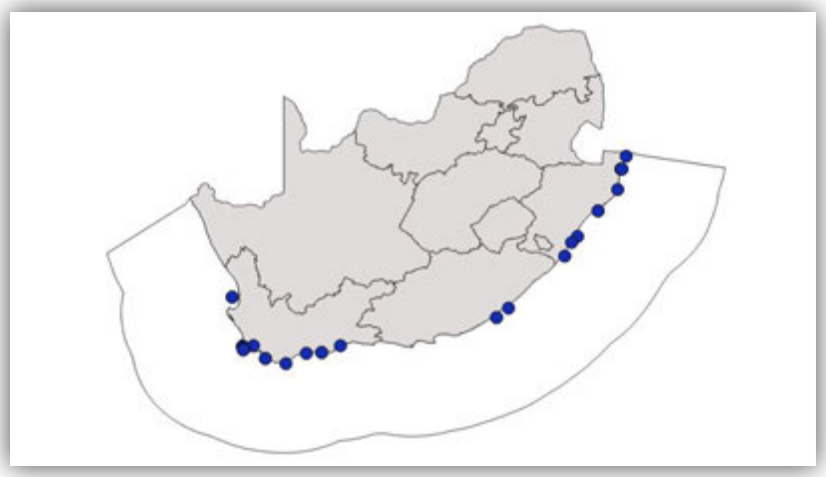

Figure 6.170. Distribution of *Ophionereis dubia dubia* in South Africa.

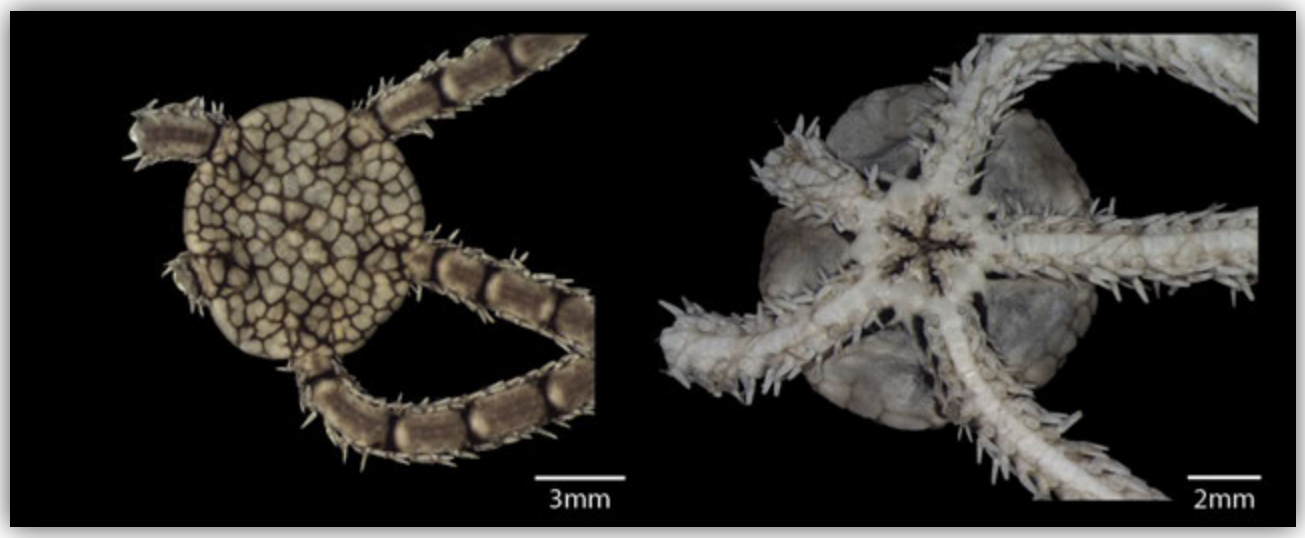

Figure 6.171. Dorsal (left) and ventral (right) views of *Ophionereis dubia dubia* (RMCA MT2360).

***Ophionereis porrecta* Lyman, 1861**
Figs 6.172 and 6.173.

Ophionereis porrecta Lyman, 1861: 260-261; Lyman, 1865: 147, figs 14, 15; Ljungman, 1867b: 310; Lyman, 1882: 161, 162, 305, 311, 314, 325; Marktanner-Turneretscher, 1887: 302; Koehler, 1898b: 75-77; Koehler, 1905a: 53-54; Clark, 1915a: 289; Clark, 1917: 440; Clark, 1921: 117, pl. 12, fig. 6, pl. 33, figs 2, 3; Clark, 1923: 344-345; Mortensen, 1933c: 373-374; Clark, 1946: 238; Clark, 1953: 80-81; Balinsky, 1957: 24; Kalk, 1958: 207;

Clark, 1967: 44; Macnae and Kalk, 1969: 130; Clark and Rowe, 1971: 122, fig. 40; Devaney, 1974: 108, 114, 174-175; Clark and Courtman-Stock, 1976: 106, 124, 180; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 207-211, figs 69, 70; Sloan *et al.*, 1979: 111; Humpreys, 1981: 25-26; Guille and Vadon, 1985: 64; Marsh, 1986: 71; Vine, 1986: 195; Sastry, 1991: 383; Liao and Clark, 1995: 275-276, fig.152; Rowe and Gates, 1995: 409; Putchakarn and Sonchaeng, 2004: 423; Stöhr *et al.*, 2008: 547, 553, fig. 5C; Stöhr, 2011a: 35-36, figs 14B, 16; Mbongwa, 2013: 16.
Ophionereis crassispina Ljungman, 1867b: 311.
Ophionereis squamata Ljungman, 1867b: 310-311.
Ophionereis sophiae Brock, 1888: 490-491.
Ophionereis aplacophora Murakami, 1943b: 215-217, fig. 2.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 15mm. Disc round, scales imbricating and distinct, dorsal scales naked, interradial scales smaller than peripheral and radial scales, ventral scales slightly smaller with few rounded granules or tubercles close to the oral area. Radial shields small, elongated oval, not always distinct, well-separated. Oral shields large, spearhead or teardrop-shaped, longer than wide. Adoral shields wide-triangular, moderate in size, not contiguous. Oral papillae 5-6, rounded, distalmost pointed and arises from adoral shield. Teeth 4-5, lowermost rounded, others square. Genital slits reach disc margin, genital papillae present. Arms long and slender, banded approximately every third segment. Dorsal arm plates trapezoidal, distal side flat, wider than long, broader in the proximal end, variety of patterns and colours including blotches and spots and alternating pale and dark patches in the lateral edges. Supplementary dorsal arm plates present along whole arm, one segment length becoming smaller distally. Ventral arm plates square with rounded edges, distal end may be concave or straight, becoming longer than wide distally. Arm spines three, conical, middle spine larger, especially in first half of arm, one-and-a-half times segment length, remaining spines slightly shorter *c.* one segment in length, sometimes banded. Tentacle scale single, elongated oval. Colour in life, disc mottled or spotted in brown, white, grey and yellow with irregular darker markings or blotches, arms banded with similar colouration to disc.

Distribution and habitat
East coast of Africa, Red Sea, Maldives, India, East Indies, Bay of Bengal, Ceylon, China, south Japan, Philippines, Australia, Gilbert Islands, Saipan, South Pacific islands, Hawaiian Islands (Clark, 1953; Kalk, 1958; Clark and Rowe, 1971; Sastry, 1991; Rowe and Gates, 1995), South Africa: Cape Town (WC) to Kosi Bay (KZN); depth range: 0-165m.
Habitat: Rock, coral sand, shell and stones.

Remarks
According to Rowe and Gates (1995) the types are in the Museum of Comparative Zoology (holotype: MCZ OPH-1592 and paratype: MCZ OPH-4105). The type locality is the Sandwich Islands, Pacific Ocean.

Figure 6.172. Distribution of *Ophionereis porrecta* in South Africa.

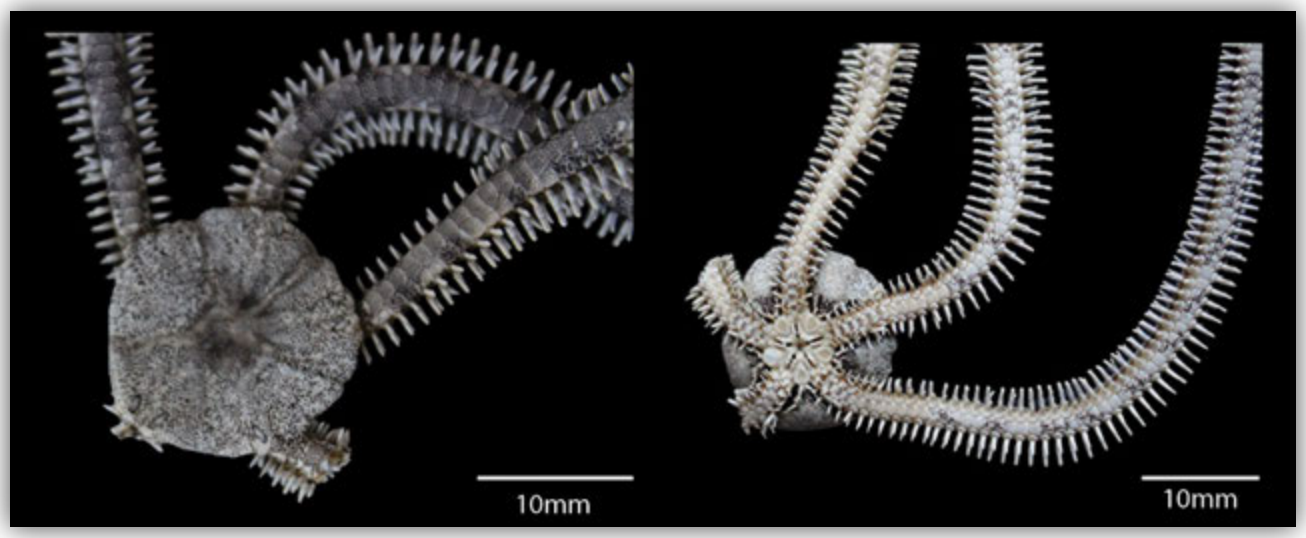

Figure 6.173. Dorsal (left) and ventral (right) views of *Ophionereis porrecta* (EKZNW AS_2_JMO_2008).

Ophionereis vivipara **Mortensen, 1933**

Figs 6.174 and 6.175.

Ophionereis vivipara Mortensen, 1933a: 191-192, fig. 7; Clark, 1953: 66, 70; Balinsky, 1957: 24; Kalk, 1958: 237; Macnae and Kalk, 1969: 130; Clark and Rowe, 1971: 122; Clark and Courtman-Stock, 1976: 106, 124, 180-181; Clark, 1980: 545.

Diagnosis *- adapted from Mortensen (1933a) and Clark and Courtman-Stock (1976).*

D.D. up to 3mm, D.D./A.L. = 1/5. Disc pentagonal, scaling minute with primary plates not distinguishable, scaling extending onto first segment of dorsal arms. Ventrally, the scaling becomes coarser towards oral area. Radial shields small, narrow or not distinguishable, well-separated. Oral shields rounded-triangular. Adoral shields well-developed, wide, contiguous. Oral papillae four, erect, apical papillae slightly larger and distalmost widest. Teeth lowermost rounded. Genital slits reach disc margin, genital papillae absent. Arms long and slender, banded approximately every 4-6 segments. Dorsal arm plates elongated rhomboidal or diamond-shaped, narrowly contiguous, longer than wide. Supplementary dorsal arm plates large, distinct concentric lines on distal side of plates. Ventral arm plates only just contiguous, longer than wide, proximal side pointed, distal side slightly convex, first

ventral arm plate elongated and narrow, second plate broadly contiguous with first plate. Arm spines three, slender, only just as long as segment. Tentacle scale single, large, elongated-oval. Colour in life, disc white with large reddish-brown dense spot in middle of disc, sometimes star-shaped with 'arms' of star reaching towards each arm, arms banded narrowly with same reddish-brown colour on every 4-6 segments.

Distribution and habitat

East Africa and Madagascar (Kalk, 1958; Clark and Rowe, 1971), South Africa: East London (EC); depth range: 0-84m.

Habitat: Among green algae, occurring with *Amphipholis squamata* and *Amphiodia dividua* (=*Ophiocomella sexradia* Duncan, 1887) on shallow sandy bottom in intertidal zone.

Remarks

No specimens were available for examination. The holotype nor the material referred to by Clark and Courtman-Stock (1976) were located during this study. Type material is recorded in the Museum of Comparative Zoology (syntype: MCZ OPH-5904) and the Natural History Museum of Denmark (paratype: ZMUC OPH-318). Type locality Cannoniers Point, Mauritius.

Figure 6.174. Distribution of *Ophionereis vivipara* in South Africa.

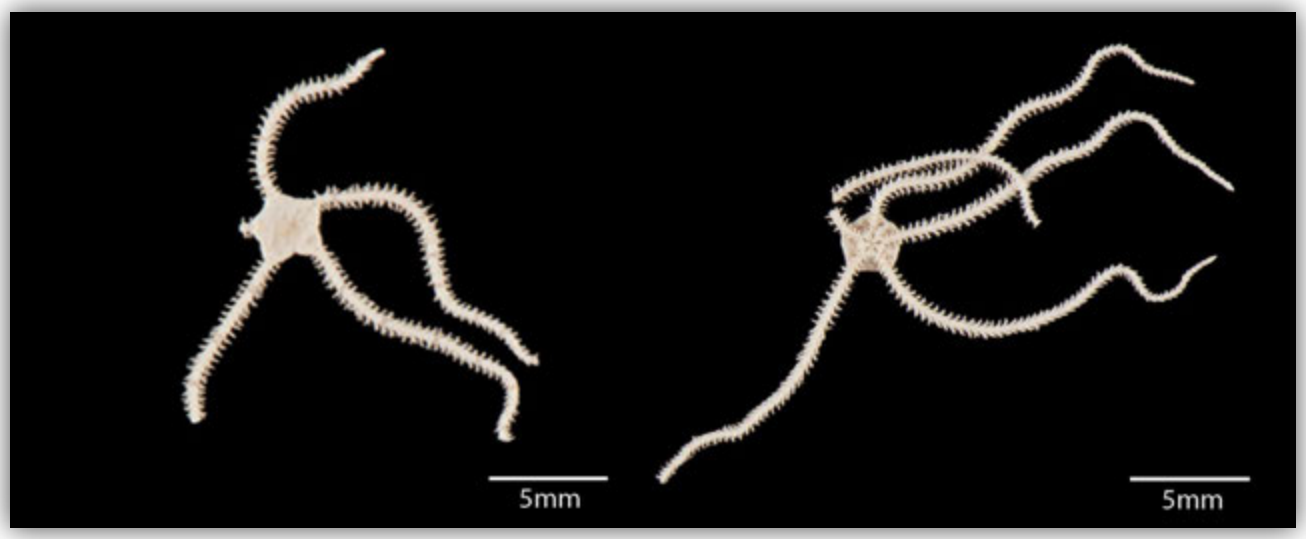

Figure 6.175. Dorsal (left) and ventral (right) views of *Ophionereis vivipara* (ZMUC OPH-318).

Family OPHIOTRICHIDAE Ljungman, 1867

Diagnosis *- adapted from Clark (1966) and Clark and Courtman-Stock (1976).*
D.D./A.L. = 1/10 or more commonly D.D./A.L. = 1/5-8. Disc scales small, juveniles with enlarged central plate. Dorsal disc often covered with armament of thorny stumps, spines or granules or a thick skin, but rarely naked. Radial shields more or less conspicuous, unless covered in armament. Jaw structure consistent in all species, with oral shields broadly rhombic, teeth broad-rectangular with compact cluster of small, rounded tooth papillae on apex, oral papillae absent, leaving the oral tentacle scale exposed. Arms stout or slender, sometimes very long, arms usually five, rarely six (only in fissiparous species). Successive dorsal and ventral arm plates usually contiguous, dorsal arm plates reduced in epizoic species. Arm spines more or less serrated and terminally rugose, may be glassy. Tentacle scale usually single and inconspicuous, if any.

Genus Macrophiothrix **H.L. Clark, 1938**

Diagnosis *- adapted from Clark (1938), Clark (1968) and Clark and Courtman-Stock (1976).*
Species often exceeding D.D. 20mm with arms being moderate to long (up to 200mm), disc soft and puffy with fine scaling covered in low thorny stumps, thorny granules, short spinelets or rugose granules, granules often obscure large radial shields. Arms mostly flexible horizontally, arm segments relatively broad. Dorsal arm plates broad, usually wider than long, hexagonal, trapezoidal, elliptical or fan-shaped, broadly contiguous. Arm spines long, serrated, sometimes smooth basally, glassy or opaque at tip (especially if clavate). Tentacle scales one.

Macrophiothrix demessa **(Lyman, 1862)**
Figs 6.176 and 6.177.

Ophiothrix demessa Lyman, 1862: 82; Lyman, 1865: 172-173; Marktanner-Turneretscher, 1887: 310; Brock, 1888: 513; Koehler, 1905a: 91-92, pl. 9, figs 5, 6; Clark, 1915a: 270; Clark, 1921: 109; Clark, H.L., 1939: 83.
Ophiothrix mauritiensis De Loriol, 1893a: 38, pl. 24, fig. 5.
Ophiothrix coronata Koehler, 1905a: 91, pl. 9, figs 8, 9; Koehler, 1922b: 217-218, pl. 40, fig. 5, pl. 41, figs 1-4, pl. 98, fig. 1; Koehler, 1930: 137; Vine, 1986: 195.
Amphiophiothrix demessa: Clark, 1946: 217; Endean, 1957: 243; Fell, 1960: 24.
Macrophiothrix mossambica Balinsky, 1957: 18, fig. 7, pl. 3, figs 11, 12.
Macrophiothrix demessa: Clark, 1968: 289-291, figs 3e, f, 4h, 5h, 7e; Clark and Rowe, 1971: 82, 114, pl. 37f; Devaney, 1974: 139-140; Clark and Courtman-Stock, 1976: 111, 138, fig. 114; Cherbonnier and Guille, 1978: 151-152, pl. 4, figs 1, 2; fig. 61: 7-9; Sloan *et al.*, 1979: 102-103; Marsh, 1986: 70; Hoggett, 1991: 1089-1094, figs 6, 7; Sastry, 1991: 374, 377, pl. 3, fig. 16; Liao and Clark, 1995: 221-222, figs 112g,113h, 114h, 115f, 116f; Milne, 2012: 155; Olbers *et al.*, 2015: 98-99, pl. 4E, F.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 12mm, arms up to 300mm, D.D./ A.L. = 1/25. Disc puffy, covered dorsally with long, thorny stumps, 2-6 terminal points, disc ventrally covered with similar stumps, but more scattered and typically with single terminal points. Radial shields triangular, two-thirds length of disc radius, covered with shorter and less numerous stumps than those on disc. Jaws elongated, oral shields broadly triangular, much wider than long. Adoral shields not contiguous. Genital slits half-way to disc margin, genital plate large, adjacent to slit, with disc spinelets not continuing to edge of genital slit. Dorsal arm plates broadly fan-shaped, about twice as wide as long or wider, broadly in contact, armed with small rugose granules or sparse stumps. Ventral arm plates wide, square to fan-shaped, but with rounded proximal edges, as long as wide, sometimes slightly longer than wide, contiguous. Arm spines up to 14, thorny over entire length, glassy, longest spine at least three times segment length, shortest

ventrally. Tentacle scale single, triangular. Colour in life, dorsal side of disc greyish with more or less conspicuous dark pink spots, ventrally lighter with less spots. Arms banded purple, pink or red with white dorsally and lighter ventrally, with 2-3 arm segments between bands. One specimen with a white longitudinal band from *c.* half way down arms.

Distribution and habitat

Mozambique, Zanzibar, Red Sea, Mauritius, Seychelles, Maldives, India, China Sea, Philippines, Australia, Hawaiian Islands (Clark and Rowe, 1971; Hoggett, 1991; Sastry, 1991; Rowe and Gates, 1995), South Africa: Aliwal Shoal (KZN) to Bhanga Nek (KZN); depth range: 0-128m.
Habitat: Concealed in coral, deep rocky crevices, under stones, coarse sand and with *Lithothamnion*.

Remarks

Olbers *et al.* (2015) recorded this as a new species to South Africa, although it was previously recorded from Mozambique (Clark and Courtman-Stock, 1976). According to Rowe and Gates (1995) the type locality is Hawaiian Islands (recorded as Sandwich Islands) and specimens are in the Museum of Comparative Zoology (holotype: MCZ OPH-2278; paratypes: MCZ OPH-2279, MCZ OPH-2280, MCZ OPH-2281 and MCZ OPH-4095).

Figure 6.176. Distribution of *Macrophiothrix demessa* in South Africa.

Figure 6.177. Dorsal (left) and ventral (right) views of *Macrophiothrix demessa* (RMCA MT2156).

Macrophiothrix hirsuta cheneyi (Lyman, 1862)

Figs 6.178 and 6.179.

Ophiothrix cheneyi Lyman, 1862: 84; Lyman, 1865: 175-176.
Ophiothrix hirsuta: Ludwig, 1899: 549; Koehler, 1905a: 95; Koehler, 1922b: 234-235, pl. 31, fig. 1, pl. 33, fig. 13; pl. 99, fig. 2.
Macrophiothrix brevipeda Clark, 1938: 290-292, fig. 20; Clark, H.L., 1939: 91.
Macrophiothrix hirsuta: Balinsky, 1957: 17-18; Kalk, 1958: 207, 214; Macnae and Kalk, 1962: 118; Macnae and Kalk, 1969: 99, 101, fig. 27b.
Macrophiothrix hirsuta cheneyi: Clark, 1968: 296-298, figs 3k, 4n, 5n, 7j; Clark and Courtman-Stock, 1976: 101, 112, 138, fig. 115; Clark, 1980: 548; Tortonese, 1980: 123; Milne, 2012: 155.

Diagnosis *- adapted from Clark (1938) and Clark and Courtman-Stock (1976).*
D.D. up to 20mm, arms up to 160mm; D.D./A.L. = 1/8. Disc round, covered in stumps dorsally and ventrally ending in three to several points, flaring, peripheral stumps mostly with 2-3 terminal points, armament close to oral shields more spiniform and scattered. Radial shields large, conspicuous, length *c*. one- to two-thirds disc radius, triangular, almost completely naked, some thorny granules along the lateral edges. Jaws slightly elongated, oral shields naked, spearhead-shaped. Adoral shields moderate in size, sometimes contiguous. Genital slits almost reaching disc margin with large genital plate on lateral side, stumps reaching edge of genital slit. Dorsal arm plates hexagonal, up to three times wider than long, lateral angles more or less rounded, distal side with a median angle, the broadest part near middle of plate, broadly contiguous, armed with tiny spines. Ventral arm plates hexagonal but almost squarish, almost as wide as long, distal edge slightly concave, proximal edge convex, contiguous. Arm spines up to ten, middle spines longest, length more than three times segment length and somewhat clavate, glassy, opaque at tip, serrated for most of length. Tentacle scales one, small, flattened and pointed. Colour in life grey and dark blue or purple, both dorsally and ventrally, dorsal arms with longitudinal light stripe bordered by two dark blue lines, ventral arms with similar stripe but less conspicuous, radial shields variegated with blue.

Distribution and habitat
Mozambique, Tanzania, Somalia, Red Sea and Southern Arabia (Clark, 1968; Clark and Courtman-Stock, 1976; Clark, 1980; Tortonese, 1980), South Africa: Zotsha River (KZN) to Bhanga Nek (KZN); depth range: 7.5-70m.
Habitat: Coarse sand, stones, pebbles and dead coral rubble.

Remarks
A number of authors have indicated the distribution of *M. hirsuta cheneyi* in South Africa as extending as far south as Mossel Bay (Clark, 1968; Tortonese, 1980), but this seems unlikely (this specimen was not located in the Natural History Museum catalogue) because the southern-most record for this species found in this study was in the vicinity of the Zotsha River (KZN) more than 300km north of Mossel Bay.

The paratype is in the Museum of Comparative Zoology (MCZ OPH-4097) and the type locality is Zanzibar, depth unknown.

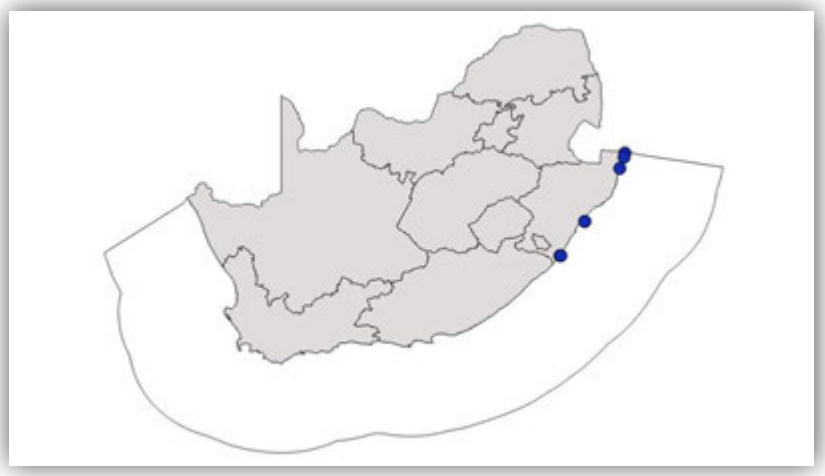

Figure 6.178. Distribution of *Macrophiothrix hirsuta cheneyi* in South Africa.

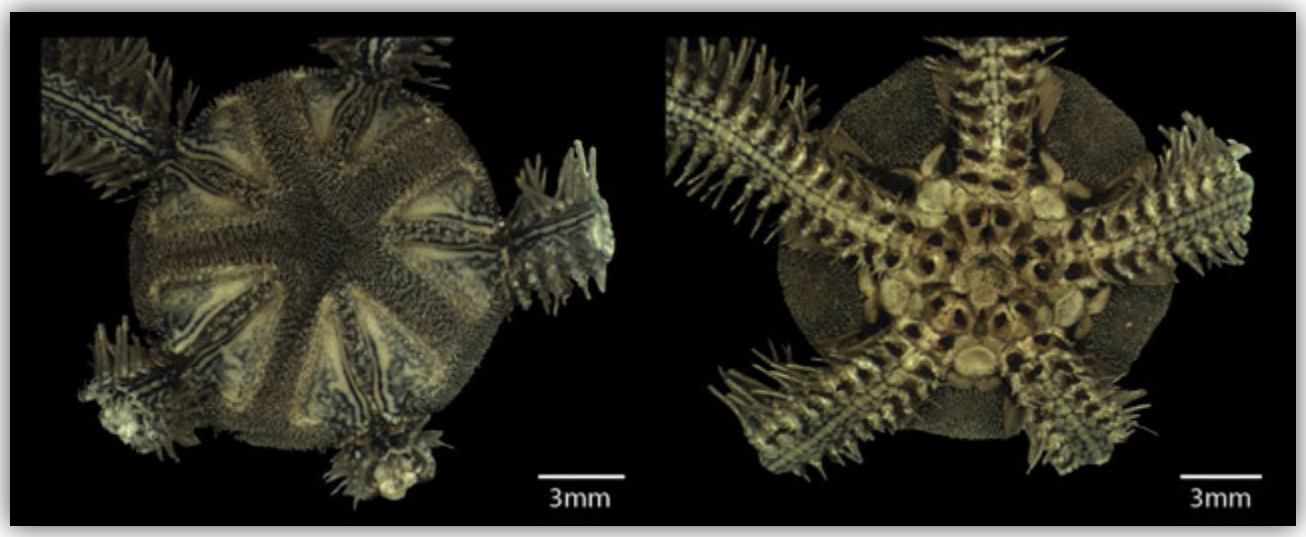

Figure 6.179. Dorsal (left) and ventral (right) views of *Macrophiothrix hirsuta cheneyi* (RMCA MT2333).

***Macrophiothrix longipeda* (Lamarck, 1816)**

Figs 6.180 and 6.181.

Ophiura longipeda Lamarck, 1816: 544.
Ophiothrix longipeda Müller and Troschel, 1842: 113; Lyman, 1879: 54; Clark, 1911: 263; Clark, 1921: 110, pl. 15, fig. 5, pl. 33, fig. 1; Clark, 1923: 340; Clark, 1932: 204.
Ophiothrix punctolimbata Von Martens, 1870: 257-258.
Ophiothrix microplax Bell, 1884: 143-144.
Macrophiothrix longipeda Clark, 1938: 288-290; Clark, 1946: 221; Balinsky, 1957: 17; Fell, 1960: 24; Clark, 1968: 300-302, figs 3m-o, 4p-r, 5p-r, 7l, m; Clark and Rowe, 1971: 82, 83, 114; Devaney, 1974: 140-141; Clark and Courtman-Stock, 1976: 101, 112, 139; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 153-154; pl. 4, figs 3, 4, figs 61: 28, 29; Sloan *et al.*, 1979: 102-103; Guille and Vadon, 1985: 62; Marsh, 1986: 70; Hoggett, 1991: 1103-1108, figs 14, 15; Sastry, 1991: 377, pl. 3, fig. 17, pl. 4, fig. 31; Liao and Clark, 1995: 226-228, figs 112b, 113b, 114b, 115b, 116b; Rowe and Gates, 1995: 413; Mbongwa, 2013: 16.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 37mm, A.L. up to 625mm; D.D./A.L. = 1/17. Disc round, puffy. Dorsal disc with thorny stumps, becoming sharper on ventral side near oral shields. Radial shields large, triangular, with some short stumps, distally concave, more than three-quarters disc radius. Arms very long. Genital slits

almost up to disc margin, sharp stumps to edge of genital slit. Jaws elongated, making oral shield far from teeth / oral papillae. Adoral shields most often contiguous. Dorsal arm plates broadly fan-shaped, at least twice as wide as long, broadly contiguous, in smaller individuals plates may be split into two, fan-shaped proximally. Ventral arm plates square, almost as long as wide, also more or less with dark spots or small blotches. Arm spines up to ten, translucent, long, three times segment length, shortest spines on ventral side, one segment length, cigar-shaped, though middle ones somewhat club-shaped. Tentacle scales single, moderately large, round. Colour in life, disc dorsally and ventrally blue or purple with blue or purple spots and blotches, radial shields spotted, ventrally similar but lighter, arms banded with white, or spotted with purple.

Distribution and habitat

Mozambique, Tanzania, Zanzibar, Aldabra, Red Sea, Madagascar, Chagos, Mauritius, Mascarene Basin, Seychelles, Sri Lanka, Singapore, south Japan, China, Philippines, Australia (Hoggett, 1991; Rowe and Gates, 1995), South Africa: Port Edward (KZN) to Kosi Bay (KZN); depth range: 8-92m. Habitat: Under coral boulders, crevices, stone slabs and broken shell. Characteristically buries its disc in crevices, or deep within coral, with two arms holding onto substrate and remaining three arms held up in water column.

Remarks

Clark and Courtman-Stock (1976) commented that *Macrophiothrix aspidota* (Müller and Troschel, 1842) should be synonymised with *M. longipeda* and suggested a revision. In addition, *M. longipeda* was recorded from Port Elizabeth by A.M. Clark in 1968, but later it was suggested this was incorrect (Clark and Courtman-Stock, 1976). Therefore, a revision and comparison between *M. aspidota* and *M. longipeda* should be undertaken.

The type material is in the National Museum of Natural History (neotype: USNM 4291) and the type locality is " 'L'Ocean austral, pres de l'Ile de France" (Mauritius), depth unknown.

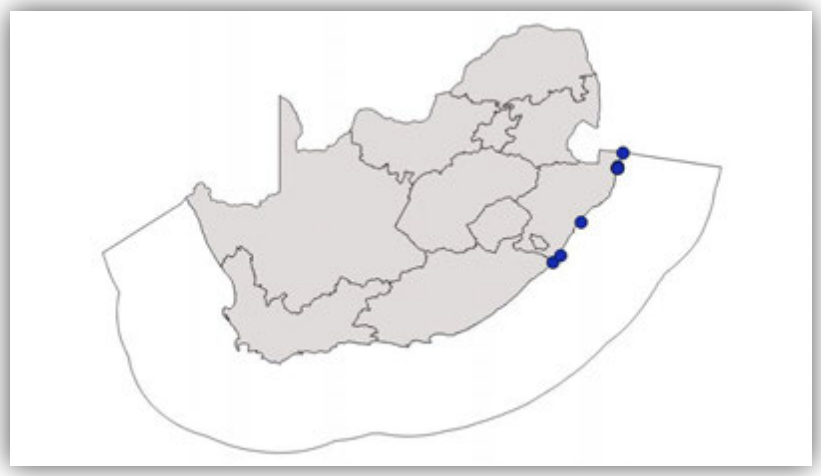

Figure 6.180. Distribution of *Macrophiothrix longipeda* in South Africa.

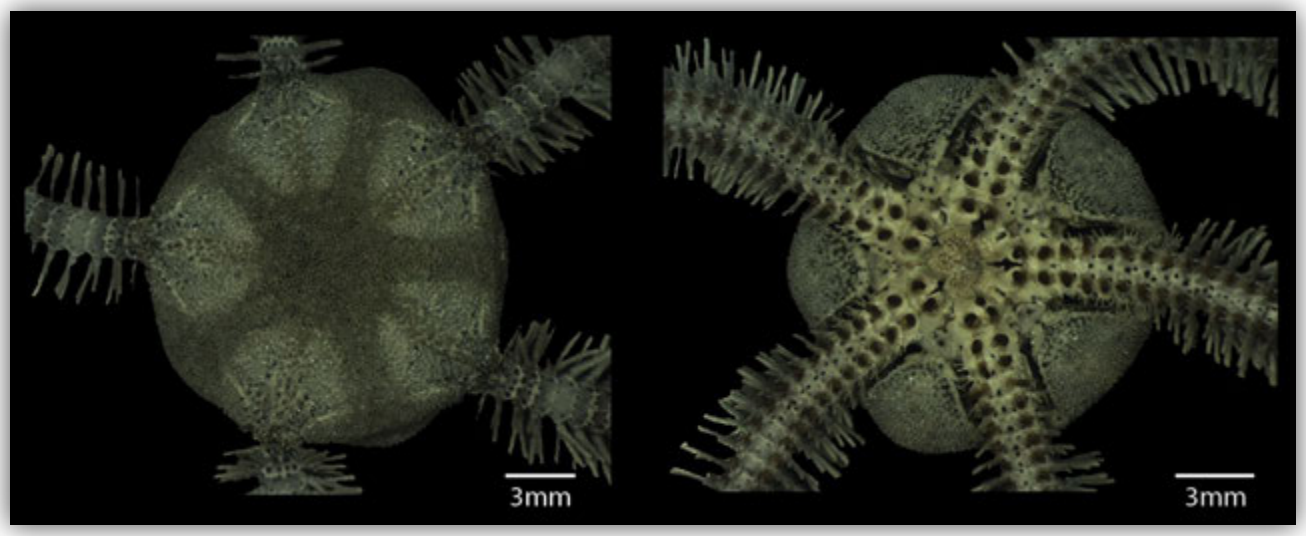

Figure 6.181. Dorsal (left) and ventral (right) views of *Macrophiothrix longipeda* (RMCA MT2160).

***Macrophiothrix propinqua* (Lyman, 1862)**

Figs 6.182 and 6.183.

Ophiothrix propinqua Lyman, 1862: 83-84; Ljungman, 1867b: 333; Lyman, 1874: 234; Marktanner-Turneretscher, 1887: 308; Brock, 1888: 510; Koehler, 1898b: 98-100, pl. 3, figs 20-22; Koehler, 1905a: 81; Clark, 1915a: 277; Clark, 1921: 113; Koehler, 1922b: 256-257, pl. 38, figs 1, 2, pl. 101, fig. 4; Murakami, 1943b: 207-208.
Ophiothrix triloba Von Martens, 1870: 260-261.
Ophiothrix bedoti De Loriol, 1893b: 420-422, pl. 15, fig. 1.
Ophiothrix schmidti Djakonov, 1930: 237-239, pl. 12, figs 1, 2.
Ophiotrichoides propinqua: Clark, 1946: 232; Balinsky, 1957: 21; Endean, 1957: 244.
Macrophiothrix schmidti: Clark, 1966: 649.
Ophiothrix (*Keystonea*) *propinqua*: Clark, 1966: 648; Clark, 1968: 283, fig. 2e; Clark and Rowe, 1971: 86-87, 107; Clark and Courtman-Stock, 1976: 102, 111, 145; Gibbs *et al.*, 1976: 127; Cherbonnier and Guille, 1978: 149, pl. 5, figs 1, 2, fig. 61: 11, 12; Sloan *et al.*, 1979: 103; Guille and Wolff, 1984: 6; Marsh, 1986: 71; Liao and Clark, 1995: 244-245, figs 116a, 129.
Ophiothrix (*Placophiothrix*) *westwardi* Devaney, 1974: 143-148, figs 8-14.
Macrophiothrix propinqua: Clark, 1980: 537; Guille and Vadon, 1985: 62; Hoggett, 1991: 1130-1133, figs 28, 29; Sastry, 1991: 378, pl. 3, fig. 18; Milne, 2012: 155; Olbers *et al.*, 2015: 99, 101, pl. 5A, B.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 12mm, arms up to 120mm; D.D./A.L. = 1/10. Disc round, scales clearly visible, with or without armament. Radial shields large, more than half disc radius, naked, disc scales in single or multiple rows between radial shields, some with tubercles or spines. Ventral interradial areas with tubercles, but somewhat sharper than dorsal ones. Oral shields diamond-shaped, wider than long, adoral shields sometimes touching. Genital slits narrow, reaching margin of disc, genital papillae absent, genital plate conspicuous. Dorsal arm plates fan-shaped to elliptical, much wider than long, especially distally, with proximal edge short, distal edge slightly trilobed, broadly contiguous for more than one-third of their breadth, some proximal-most plates with point on distal end. Ventral arm plates square and slightly wider than long, most often with slight distal notch. Arm spines up to eight, finely serrated over total length and distal spines with long thorn, orientated proximally, glassy, longest twice segment length, shortest on ventral side. Tentacle scale one, large, oval. Colour in life pink, purple with patterns on disc, arms banded every 3-4 segments. Radial shields reddish, sometimes with blue patches, distal edge outlined with white.

Distribution and habitat
Mozambique, Tanzania, Kenya, Somalia, Red Sea, Madagascar, Mauritius, Mascarene Basin, Aldabra, Comoros, Seychelles, India, (Rowe and Gates, 1995; Richmond, 2002), South Africa: Aliwal Shoal (KZN) to Kosi Bay (KZN); depth range: 0-80m.
Habitat: Associated with coral, coral slabs, beach rock, sponges and found in crevices.

Remarks
See Olbers *et al.* (2015) for additional remarks. The type material is in the Museum of Comparative Zoology (holotype: MCZ OPH-2399) and the type locality is Kiribati (as Kingsmill Ils), depth unknown.

Figure 6.182. Distribution of *Macrophiothrix propinqua* in South Africa.

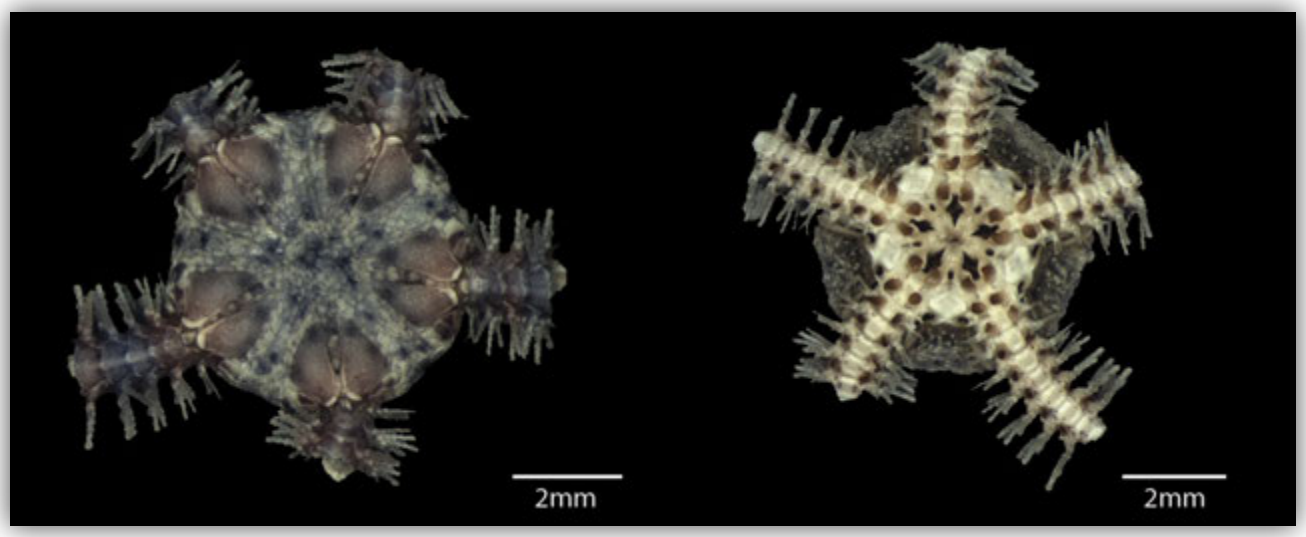

Figure 6.183. Dorsal (left) and ventral (right) views of *Macrophiothrix propinqua* (RMCA MT2216).

Genus Ophiocnemis Müller and Troschel, 1842

Diagnosis *- adapted from Müller and Troschel (1842), Lyman (1882), Cherbonnier and Guille (1978).*
Dorsal disc scales with granules, radial shields very large, naked. Ventral disc finely scaled, teeth present, no oral papillae, dorsal arm plates trapezoid and wider than long. Arm spines numerous, rounded, not translucent.

Ophiocnemis marmorata (Lamarck, 1816)

Figs 6.184 and 6.185.

Ophiura marmorata Lamarck, 1816: 543.
Ophiocnemis marmorata: Müller and Troschel, 1842: 87-88; Lyman, 1865: 152; Lyman, 1882: 229, pl. 42, figs 14, 15; Duncan, 1887: 103-104; Döderlein, 1888: 833, pl. 31, figs 6a-c; Koehler, 1905a: 112; Clark, 1923: 341; Koehler, 1926: 27; Koehler, 1930: 187-188; Clark, 1915a: 283; Mortensen, 1934: 5; Clark, 1938: 318; Clark, 1946: 229; Clark and Rowe, 1971: 84-85, 106, pl. 17, fig. 2; Clark, 1974: 94; Clark and Courtman-Stock, 1976: 101, 111, 139, fig. 107; Cherbonnier and Guille, 1978 154-155; pl. 3, figs 5, 6; Liao and Clark, 1995: 231-232, fig. 118; Mbongwa, 2013: 16.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 20mm, D.D./A.L. = *c.*1/6. Arms relatively long, triangular in cross section. Disc round, dorsally covered with scales and granules, granules restricted to narrow bands between radial shields and in interradial areas, peripheral granules slightly elongated and disc scaling ends abruptly at disc margin. Ventral interradial areas with naked skin, with fine scales, sometimes with scattered granules close to oral shields. Radial shields naked, large, almost full disc radius. Genital slits reach half-way to disc margin and genital papillae present on large genital plates. Oral shields triangular, about three times wider than long. Adoral shields rounded and sometimes contiguous. Dorsal arm plates elliptical, four times as wide as long, convex on proximal side. Ventral arm plates not contiguous, hexagonal, with distal notch both proximally and distally, wider than long, becoming square distally but still slightly wider than long. Arm spines up to five, tapering, finely serrated or smooth. Middle spine up to four times segment length with uppermost spine same length as segment. Tentacle scale one, very small. Colour in life dorsally green, grey and white with white patches along dorsal arms, lighter ventrally, interradial areas brown, some with darker patches adjacent to genital slits.

Distribution and habitat
Tanzania, Mozambique, Madagascar, Sri Lanka, East Indies, Bay of Bengal, China, south Japan, Philippines, Australia (Clark and Rowe, 1971; Liao and Clark, 1995; Rowe and Gates, 1995), South Africa: Isipingo (KZN) to Dog Point (KZN); depth range: 0-100m.
Habitat: Sand, shells, associated with rhizostome jellyfish, possibly *Rhopilema nomadica* and *Cephea* species.

Remarks
Clark and Courtman-Stock (1976) stated that the tentacle scales were absent on large tentacle pores, but this was not the case in the material examined, in which the tentacle scales were visible but very small. This species is known as the ‘hitch-hiker brittle star’ as it is most often found on jellyfish; most of the records in the Iziko South African Museum collection being from jellyfish that have washed ashore. There does not appear to be a difference between size classes living within jellyfish versus specimens found in sand and shelly sediment.

The type material was suspected to be in the National Natural History Museum, Paris (MNHN) (Rowe and Gates, 1995) but was not located and the type locality is unknown.

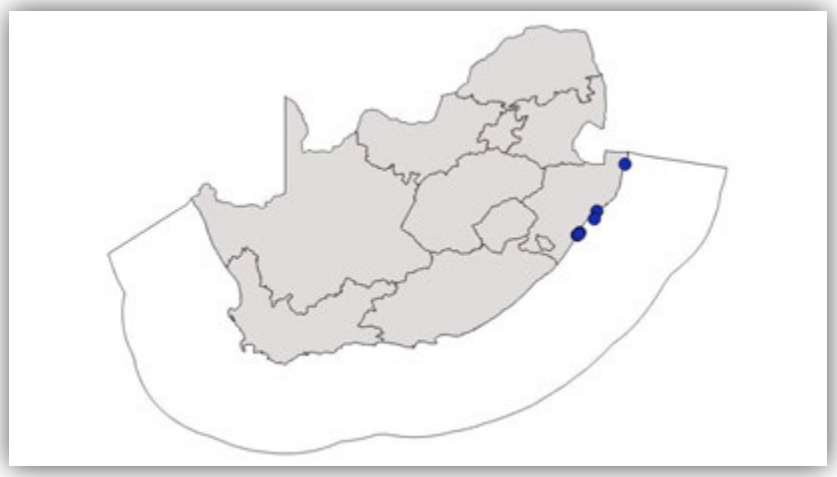

Figure 6.184. Distribution of *Ophiocnemis marmorata* in South Africa.

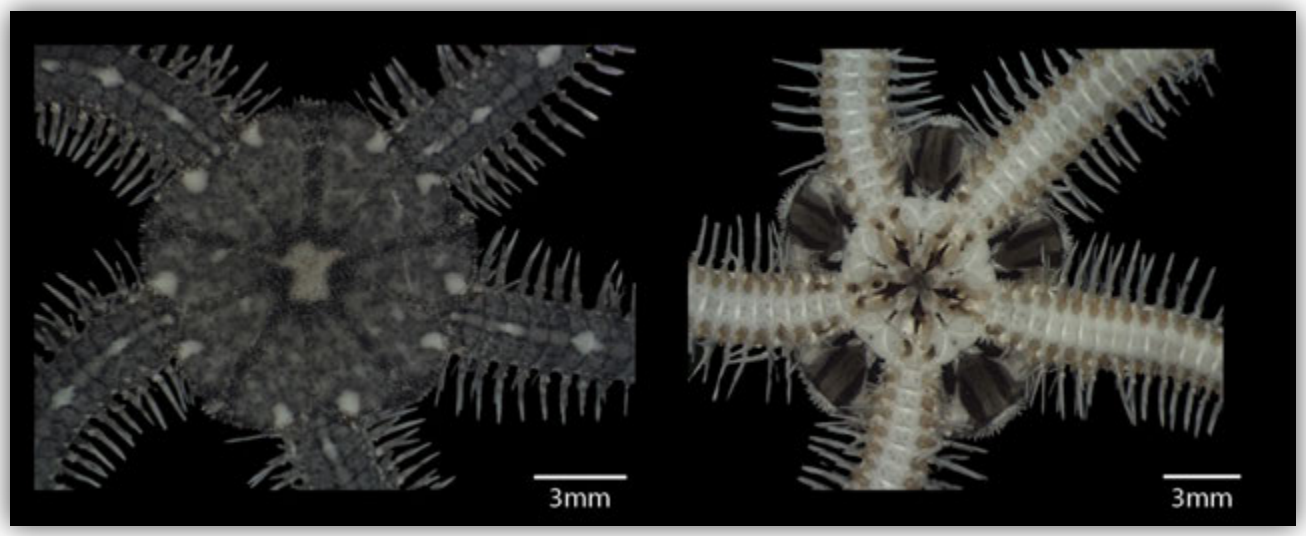

Figure 6.185. Dorsal (left) and ventral (right) views of *Ophiocnemis marmorata* (RMCA MT2510).

Genus Ophiogymna **Ljungman, 1866**

Diagnosis *- adapted from Koehler (1922b) and Clark and Courtman-Stock (1976).*
Disc soft and puffy; disc scales and majority of radial shields obscured by thick skin; scales bearing thorny stumps or spinelets. Arms very long, flexible, often forming circles; dorsal arm plates fragmented in large specimens but entire in small specimens; arm spines slender, opaque, fairly smooth except towards tips; tentacle scale present proximally, or possibly absent.

Ophiogymna capensis **(Lütken, 1869)**

Fig. 6.186 and 6.187.

Ophiothrix capensis Lütken, 1869: 59, 100; Clark, 1923: 340.
Ophiogymna capensis: Mortensen, 1933c: 340-341, figs 52b, 53b, pl. 19, fig. 26; Clark and Courtman-Stock, 1976: 101, 113-114, 140, fig. 119.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. unknown. Disc puffy, soft, covered in skin, armed with slender spines placed between large radial shields. Dark line between each pair of radial shields extending onto approximately first five arm

segments, but ending abruptly. Arms banded with dark bands every third to sixth segment dorsally, with colour extending onto uppermost arm spine, band may be constricted to sides or complete. Skin also somewhat finely dotted on dorsal side. Dorsal arm plates fragmented, but obscured by skin. Arm spines up to eight, long and thin. Tentacle scales absent.

Distribution and habitat
South Africa: off Cape of Good Hope (WC); depth range: unknown.
Habitat: Epizoic on gorgonians.

Remarks
Endemic to South Africa (see Table 7.4). This species has not been recorded again since its original description. Mortensen (1933c) suggested that *Ophiogymna capensis* may be *O. pulchella* (Koehler, 1905), as he could not find any reliable characters that differed. There is no material of *O. pulchella* or *O. capensis* in the Iziko South African Museum collection, therefore no material was examined or compared.

In addition, according to Clark and Courtman-Stock (1976), the type material is in the Natural History Museum of Denmark (syntype: ZMUC OPH-478) and the type locality, given as 'Cap' by Lütken, creates uncertainty that Lütken was in fact referring to the Cape of Good Hope in South Africa.

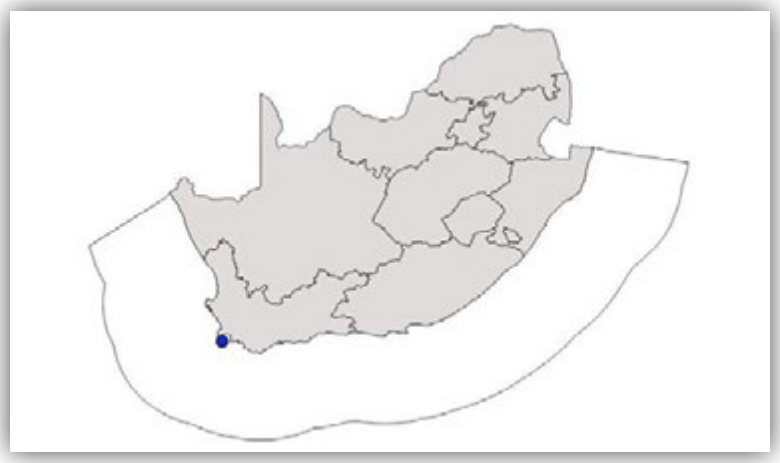

Figure 6.186. Distribution of *Ophiogymna capensis* in South Africa.

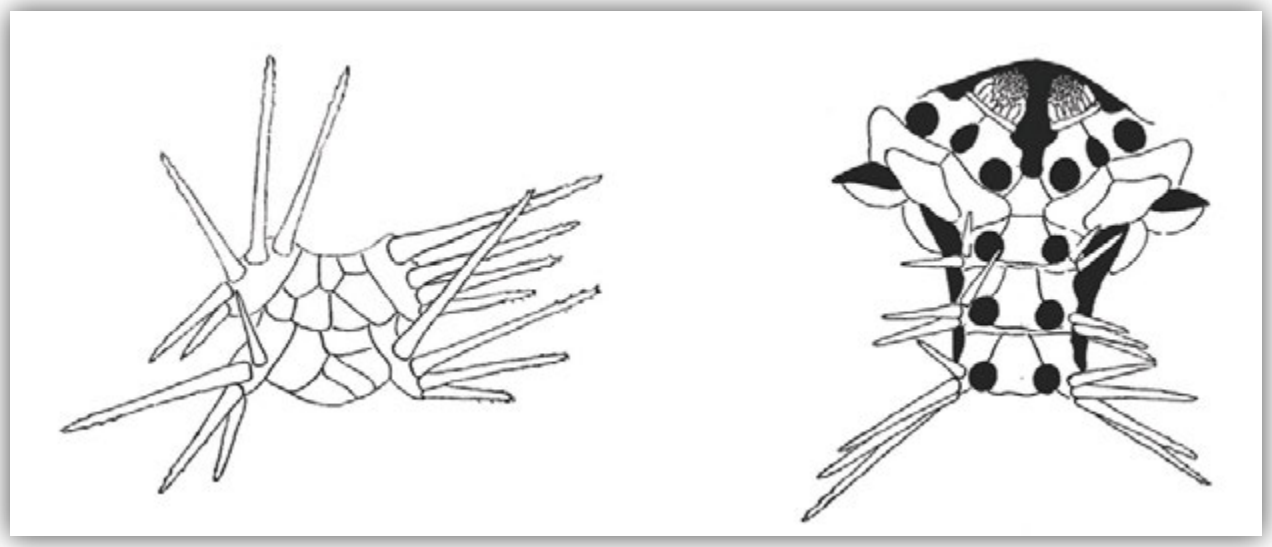

Figure 6.187. Dorsal (left) and ventral (right) views of *Ophiogymna capensis* (ZMUC OPH-478, from Mortensen (1933)).

***Ophiogymna fulgens* (Koehler, 1905)**
Fig. 6.188 and 6.189.

Ophiothrix fulgens Koehler, 1905a: 107-109, pl. 10, figs 3-6.
Ophiogymna fulgens Koehler, 1922b: 288-292, pl. 42, figs 1-8, pl. 43, figs 9, 10, pl. 44, fig. 8, pl. 60, fig. 6, pl. 103, fig. 8; Koehler, 1930: 189; Mortensen, 1933c: 338-340, figs 52a, 53a, pl. 19, fig. 25; Clark and Courtman-Stock, 1976: 101, 114, 140, fig. 106; Irimura, 1982: 62, fig. 37, pl. 11, fig. 6; Imaoka *et al.*, 1991: 147.

***Diagnosis** - adapted from Clark and Courtman-Stock (1976) and Mortensen (1933c).*
D.D. up to 12mm. Disc armament variable, many slender spines and / or rugose stumps. Radial shields large, triangular, sometimes contiguous, covered in skin except in distal parts. Ventral interradial areas covered in thin skin, sometimes armed with spines. Oral shields variable in shape, rhombic, elliptical or pentagonal, wider than long. Adoral shields slender. Genital slits long and slender. Arms long, twisting, covered in skin. Dorsal arm plates only fragmented basally, if at all, trapezoid, proximal side concave, distal edge convex, lateral angles blunt, contoured with a median distal swelling but sunken proximally, plates not contiguous, separated narrowly by skin, plates slightly wider than long. Ventral arm plates similar. Arm spines serrated, hyaline, slender, up to eight, spines on segments two, three and four may be clavated or rounded at tip. Tentacle scale small, sometimes present on proximal pores only. Colour in life completely white or pink, or rosy red with pink patches, arms banded dorsally.

Distribution and habitat
Indo-West Pacific, Indonesia, Japan (Koehler, 1922b, Imaoka *et al.*, 1991); South Africa: Durban (KZN); depth range: 3-923m.
Habitat: Clinging to gorgonians.

Remarks
Ophiothrix fulgens has been put forward as a synonym of *Ophiogymna pellicula* (Rowe and Gates, 1995). Unfortunately the types of both species were not available and thus this could not be investigated.

No specimens were examined and no records were found in the Iziko South African Museum. The type material is in the National Natural History Museum (syntype of *Ophiothrix fulgens*: MNHN-IE-2013-10205), type locality is Paternoster Island, Lesser Sunda Islands (Indonesia), depth 36m.

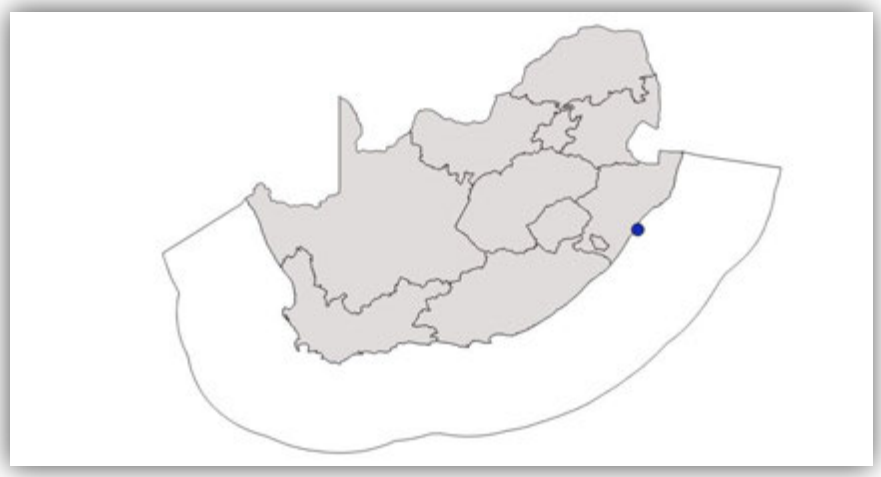

Figure 6.188. Distribution of *Ophiogymna fulgens* in South Africa.

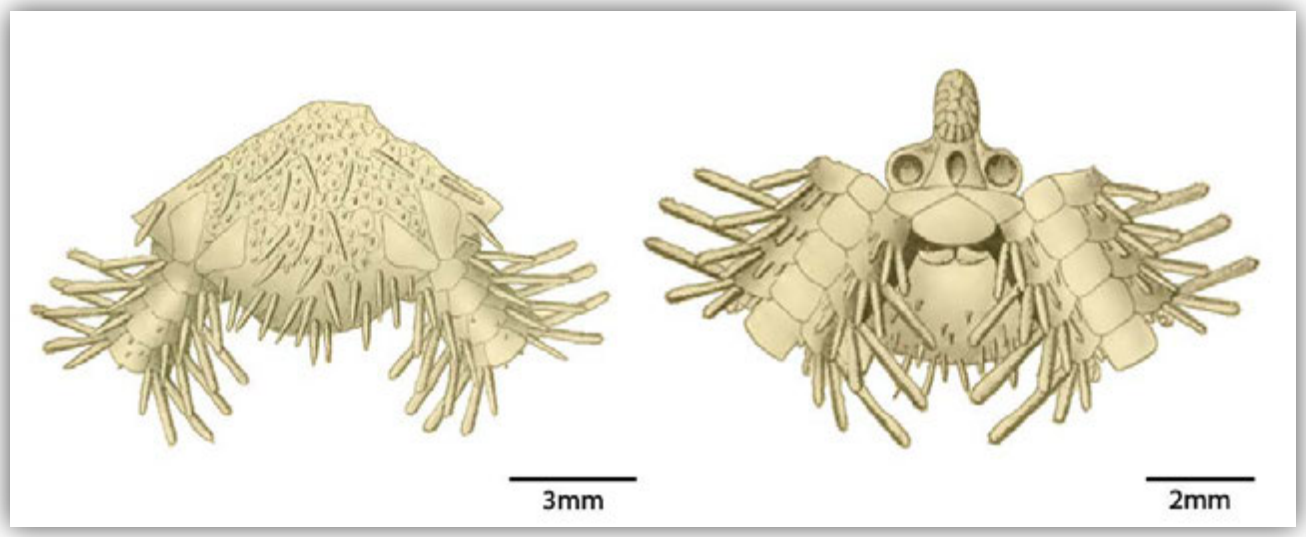

Figure 6.189. Dorsal (left) and ventral (right) views of *Ophiogymna fulgens* (holotype of *Ophiothrix fulgens,* from Koehler (1905)).

Genus Ophiothela Verrill, 1867

Diagnosis - *adapted from Verrill (1869) and Clark and Courtman-Stock (1976).*
Body covered by thick skin obscuring arm plates, radial shields very large, dorsal disc armament variable with tubercles, spines or granules, interradial areas minimal and covered in spines. Dorsal arm plates covered in granules, may be fragmented or rudimentary and restricted to few basal segments. Ventral arm plates may be visible through skin. Arms relatively short, flexible dorso-ventrally. Arm spines short and finely rugose, turned slightly downwards. Tentacles scales reduced or absent. Associated with gorgonians, crinoids, cidarids and pennatulids.

Ophiothela danae Verrill, 1869

Figs 6.190 and 6.191.

Ophiothela danae Verrill, 1869: 391; Lyman, 1882: 230; Marktanner-Turneretscher, 1887: 313-314; Döderlein, 1896: 297, pl. 17, fig. 25; Koehler, 1898b: 89; Koehler, 1905a: 117-118; Koehler, 1907: 340; Clark, 1915a: 284; Matsumoto, 1917: 230-232, fig. 67; Koehler, 1922b: 297-298, pl. 59, figs 1-3, pl. 103, fig. 1; Mortensen, 1933c: 342; Clark and Rowe, 1971: 116, pl. 14, fig. 5; Clark, 1974: 470; Cherbonnier and Guille, 1978: 158-159, pl. 8, figs 3, 4; Mortensen, 1940: 68; Murakami, 1942: 20; Murakami, 1943a: 180; Clark and Spencer Davis, 1966: 599; Clark and Courtman-Stock, 1976: 101, 114, 141; Humpreys, 1981: 22; Price, 1981: 7, 10; Irimura, 1982: 57-59, fig. 32, pl. 11, figs 1-6; pl. 12, figs 1, 2; Guille and Vadon, 1985: 62; Marsh, 1986: 71; Vine, 1986: 195; Liao and Clark, 1995: 238, fig.124; Rowe and Gates, 1995: 419-420; Price and Rowe, 1996: 74.
Ophiothela isidicola: Lütken, 1872: 92, pls 1, 2, fig. 4; De Loriol, 1893a: 52-53; Clark, 1915a: 285.
Ophiothela dividua Von Martens, 1879: 127-130, figs 1-4; Clark, 1923: 343; Balinsky, 1957: 22.
Ophiothela verrilli Duncan, 1879: 477-479, pl. 11, fig. 33.
Ophiothela danae var. *involuta* Koehler, 1898b: 88-90.
Ophiothela caerulea Clark, 1915a: 283, pl. 14, fig. 1
Ophiothela hadra Clark, 1915a: 284-285, pl. 14, fig. 2.

Diagnosis - *adapted from Clark and Courtman-Stock (1976) and Clark and Rowe (1971).*
D.D up to 7mm. Disc and arms covered in skin, disc armament extremely variable with rounded tubercles and granules, rough appearance or smooth with few granules or tubercles. Radial shields tumid with few tubercles on periphery, contiguous for full length. Dorsal interradial areas with larger

tubercles. Ventral disc with no spines. Oral shields inconspicuous, triangular. Genital slits round. Arms usually six, but very small individuals may have only three arms and only half a disc. Dorsal arm plates covered with tubercles large and small intermixed, proximal part of arms banded with darker bands, up to six arms. Ventral arm plates hexagonal with distal edge either straight or slightly convex. Arm spines up to six, blunt, rugose, tips barbed, becoming narrow distally. Colour in life variable, black to white, pinkish grey with dark bands or spots dorsally, blue linear patterns and reddish markings, yellow, orange with white radial shields, purple with purple and white banded arms.

Distribution and habitat

Mozambique, Kenya, Red Sea, Madagascar, Mascarene Basin, Persian Gulf, Pakistan, India, Sri Lanka, Bay of Bengal, East Indies, Maldives, China, south Japan, Philippines, Indonesia, Sumatra, south Pacific Islands and Australia (Murakami, 1942, Clark and Rowe, 1971; Rowe and Gates, 1995; Price and Rowe, 1996), South Africa: Port Elizabeth (KZN) to Durban (KZN); depth range: 0-220m. Habitat: Associated with gorgonians, macro-algae, *Millepora species* and sponges.

Remarks

Eleven syntypes of *Ophiothela dividua* were examined at the Royal Belgian Institute of Natural Sciences (RBINS I.G. 6752/OPH.187).

Clark (1974) reported that the syntypes were attached to the Indo-Pacific gorgonian *Melithaea ochracea* (presumably misspelt as *Melitaea ochracea*). Type material is in the Museum of Comparative Zoology (MCZ OPH-2492 and MCZ OPH-2631) and the type locality is Fiji Island (Rowe and Gates, 1995), depth unknown.

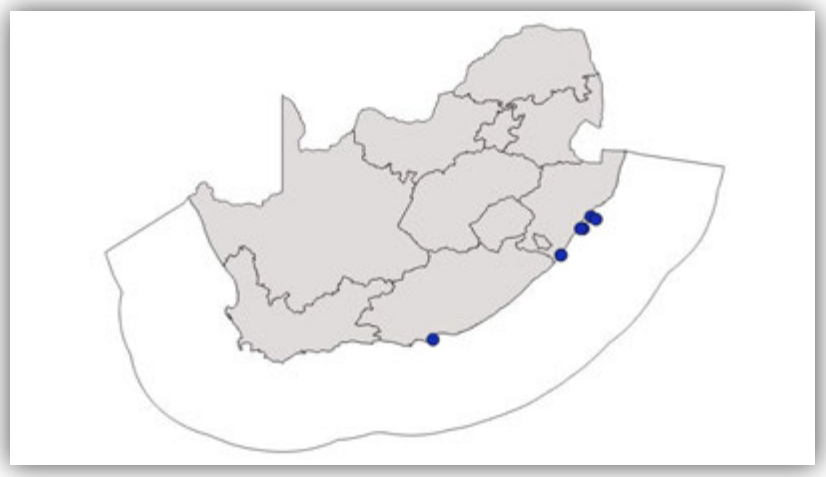

Figure 6.190. Distribution of *Ophiothela danae* in South Africa.

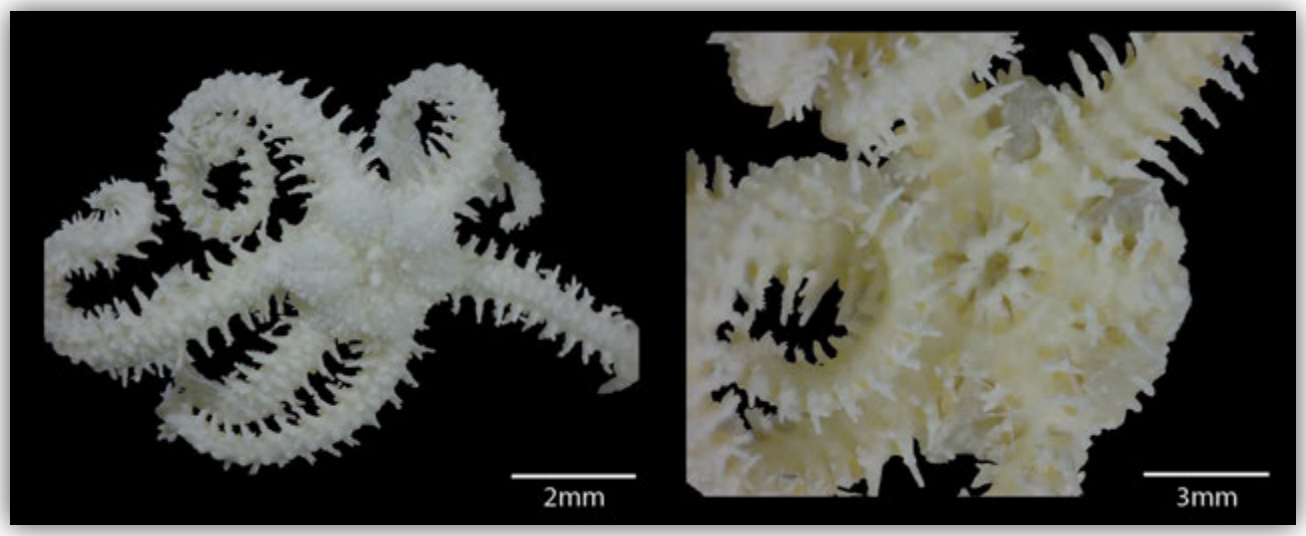

Figure 6.191. Dorsal (left) and ventral (right) views of *Ophiothela danae* (SAMC A23259).

Ophiothela venusta (de Loriol, 1900)

Figs 6.192 and 6.193.

Ophiocnemis venusta De Loriol, 1900: 81-84, pl. 8, figs 2, 3.
Ophiopsammium nudum Clark, 1923: 341.
Ophioteresis beauforti Engel, 1949: 139-143, figs 1, 2.
Ophiothela beauforti: Balinsky, 1957: 22-24, pl. 4, fig. 16; Clark and Rowe, 1971: 117, pl. 14, figs 10-12.
Ophiothela nuda: Clark, 1974: 469; Clark and Courtman-Stock, 1976: 101, 114, 141, fig. 120; Cherbonnier and Guille, 1978: 160-162, pl. 9, figs 1-6, fig. 62.
Ophiothela venusta: Clark and Rowe, 1971: 117, pl. 14, fig. 6; Olbers *et al.*, 2014: 14, pl. 2A.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 10mm. Disc round or pentagonal, armament shows great variability, may be naked or with scattered blunt spines or granules over interradial areas both dorsally and ventrally. Radial shields very large, triangular, reaching almost centre of disc, mostly naked, large tubercles present in single row between radial shields, with disc scales present in interradial areas and at centre of disc, radial shields not contiguous. Whole specimen covered in thick skin, concealing dorsal and ventral arm plates. Arms five, dorsal arm plates absent, may be naked, densely or sparsely covered in small round tubercles. Ventral arm plates triangular if visible, with shallow furrow down length of arm. Arm spines up to seven, mostly six, short, opaque and finely rugose, basal ones sometimes webbed, some lowermost spines have hooks facing proximally. Ventral disc with spines in interradial areas. Oral shields half-moon or quadrangle in shape. Genital slits moderate in size, about half way to disc margin, no genital papillae. Tentacle scales absent. Disc colour from pale pink to dark purple, lighter ventrally, arms mostly banded dorsally, but not ventrally.

Distribution and habitat
Mozambique, Tanzania, Kenya, Madagascar, Comoros, Seychelles, South East Arabia, East Indies and Australia (Clark and Rowe, 1971, Rowe and Gates, 1995, Stöhr, 2007g), South Africa: Zotsha River (KZN) to Kosi Bay (KZN); depth range: 0-66m.
Habitat: Stones, muddy sand, shells and sponges and among macro algae.

Remarks
Various authors have successfully separated *Ophiothela* species on morphological characters with Cherbonnier and Guille (1978) tabulating these differences. In the case of the South African material,

these differences are not obvious and it is uncertain that the two South African species are in fact distinct. Clark (1976) suggested that the Indo-West Pacific *Ophiothela* species are conspecific and molecular analysis was suggested by Hendler *et al.* (2012). Similarly, further investigations are required for the South African material.

On one specimen, a smaller individual was found (D.D. = 1mm) attached to the dorsal side of a larger specimen (D.D. = 3mm). This may be a juvenile of *O. venusta,* but this requires confirmation.

The type material is in the Natural History Museum, Genève (syntypes: MHNG-INVE-78692; Jean Mariaux, pers. comm.) and the type locality is Singapore, depth unknown.

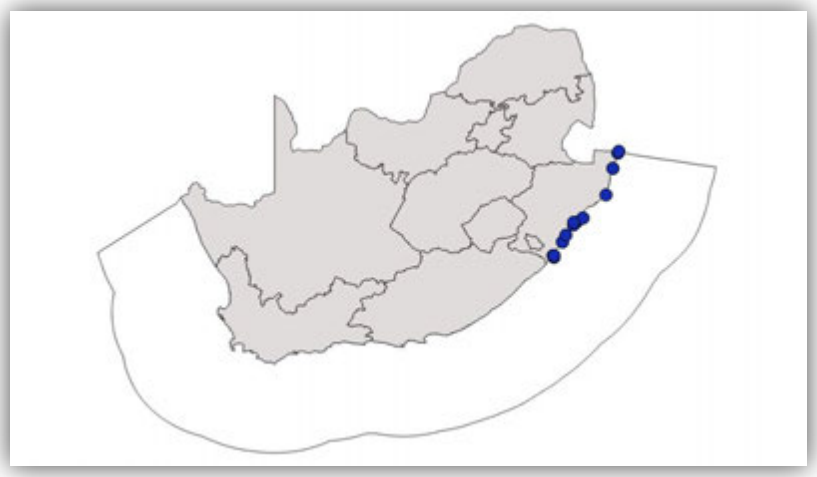

Figure 6.192. Distribution of *Ophiothela venusta* in South Africa.

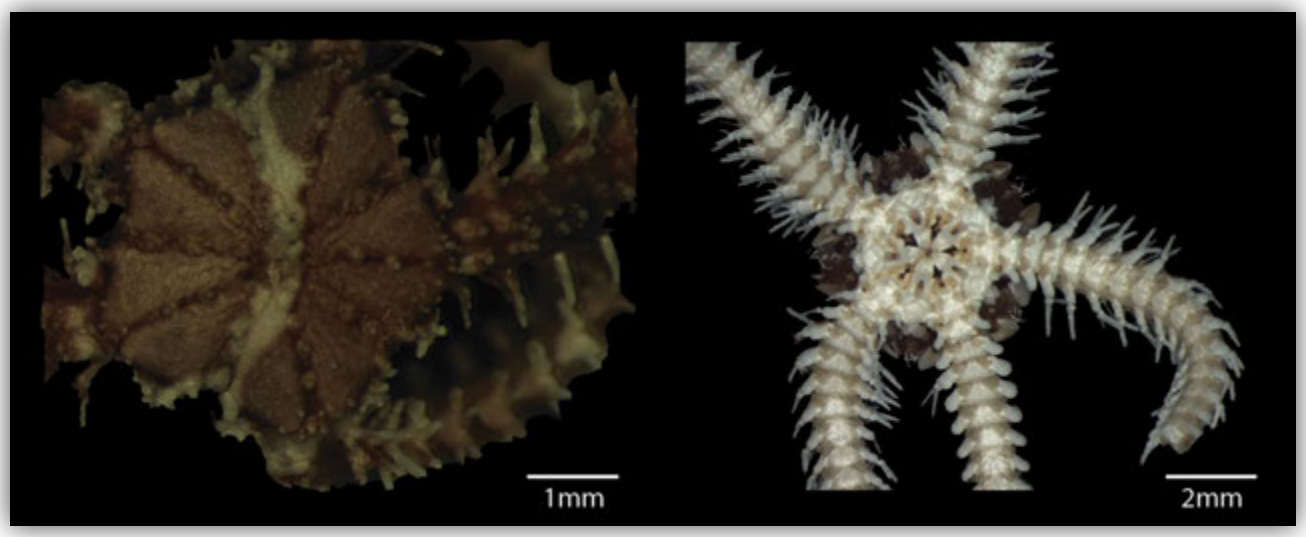

Figure 6.193. Dorsal (left) and ventral (right) views of *Ophiothela venusta* (RMCA MT2213 (dorsal); RMCA MT2356 (ventral)).

Genus Ophiothrix Müller and Troschel, 1840

Diagnosis *- adapted from Clark (1966) and Clark and Courtman-Stock (1976).*
D.D/A.L rarely more than 1/10, usually *c.* 1/4-8. Disc scaling obscured by spines, spinelets or stumps, sometimes extending onto radial shields. Ventral disc with thorny stumps and granules, ventral armament always present. Radial shields flat. Dorsal arm plates rhombic or fan-shaped, hexagonal,

trapezoidal, may or may not be broadly contiguous. Arms mostly flexible horizontally. Arm spines usually long and glassy, more or less serrated and tapering. Tentacle scale single.

Subgenera of *Ophiothrix* are distinguished as follows:
Acanthophiothrix: Disc often contracted in interradial areas, disc covered in spines and thorny stumps. Radial shields naked, but may have few small and marginal stumps and / or granules. Dorsal arm plates hexagonal, trapezoidal or fan-shaped, broadly contiguous, may be as long as wide. Disc diameter rarely more than 17mm.
Ophiothrix: Disc covered in spines, stumps and granules. Radial shields naked, or sometimes with small and marginal stumps. Dorsal arm plates elliptical or fan-shaped, not broadly contiguous, slightly wider than long. Disc diameter rarely more than 20mm.

Ophiothrix (Acanthophiothrix) proteus Koehler, 1905

Figs 6.194 and 6.195.

Ophiothrix proteus Koehler, 1905a: 100-101; Koehler, 1922b: 260-261, pl. 36, fig. 3, 4, pl. 101, fig. 3; Koehler, 1930: 147-148; Clark, 1915a: 277; Day, 1974: 94; Vine, 1986: 195.
Placophiothrix proteus: Clark, H.L., 1939: 86; Balinsky, 1957: 21; Clark, 1967: 47; Macnae and Kalk, 1969: 130.
Ophiothrix (*Acanthophiothrix*) *proteus*: Clark, 1966: 648; Clark and Rowe, 1971: 111, pl. 15, fig. 5; Clark, 1974: 465-466, fig. 11a, b; Clark and Courtman-Stock, 1976: 101, 112, 142, figs 110, 114; Cherbonnier and Guille, 1978: 147-148, pl. 6, figs 3, 4; fig. 61: 10-14; Guille and Vadon, 1985: 63; Liao and Clark, 1995: 240-241, fig. 125; Rowe and Gates, 1995: 424; Olbers *et al.*, 2014: 14, pl. 2B; Milne, 2012: 155.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 17mm, D.D./A.L. = 1/10. Disc round, dorsally disc armed with both spinelets and scattered tubercles with thorny tips, spines densely scattered between radial shields and in interradial areas, with marginal spines being thinner and sharper, centre of disc with dense cluster of spines. Radial shields large, triangular, with distal edge concave, long but do not reach centre of disc, mostly naked with few scattered spines or stumps. Ventrally, interradial areas densely packed with spines. Genital plate relatively small, but distinct. Genital slits half-way to disc margin, genital papillae absent. Oral shields elliptically oval with sharp point on proximal side, much wider than long. Adoral shields may or may not be contiguous. Dorsal arm plates hexagonal or fan-shaped, wider than long, consecutive plates in contact for less than one-third of their width, dorsal ridge on arm plates giving arm carinate appearance. First 3-4 ventral arm plates convex on distal side, but becomes straight, plates rectangular, wider than long. Arm spines up to six, serrated, six times segment length, uppermost spines longest with lowermost being just longer than stumps, serrated more than at base of spines with spines becoming smoother distally. Arms with large tentacle pores, especially basally. Tentacle scale one, small, slightly elongated. Colour in life brownish green with yellow or white line bordered by two dark lines of dark purple or green, longitudinal white stripe along entire length of arm, with two darker lines on either side.

Distribution and habitat
Mozambique, Madagascar, Red Sea, East Indies, southern China, Indonesia, Australia (Clark and Courtman-Stock, 1976; Liao and Clark, 1995; Rowe and Gates, 1995; Stöhr, 2007h), South Africa: Port Shepstone (KZN) to Kosi Bay (KZN); depth range: 0-125m.
Habitat: Stones, mud, sand, shells and *Cymodocea* beds.

Remarks
A distinctive feature of this species is the keel along the dorsal arm plates and the white longitudinal line with dark lines either side. The type material is in the Zoological Museum Amsterdam (now

Naturalis) (ZMA.ECH.O.2548; ZMA.ECH.O.2544; ZMA.ECH.O.2551 and ZMA.ECH.O.2547) and the type locality is Indonesia, depth unknown.

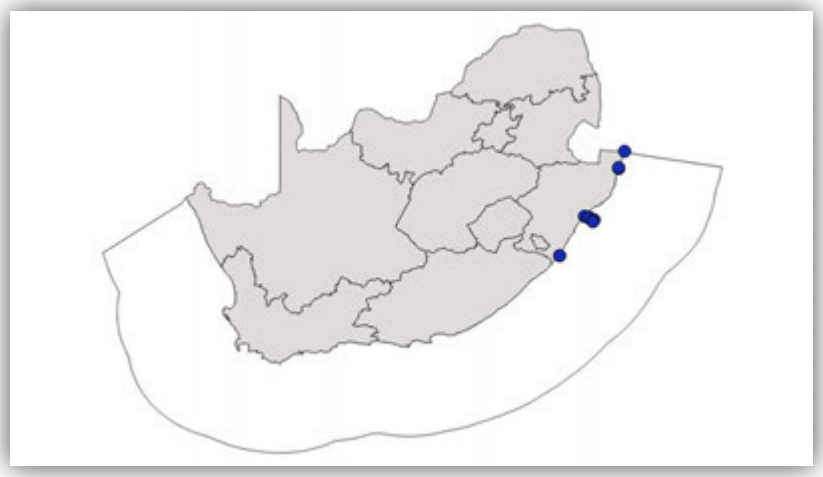

Figure 6.194. Distribution of *Ophiothrix* (*Acanthophiothrix*) *proteus* in South Africa.

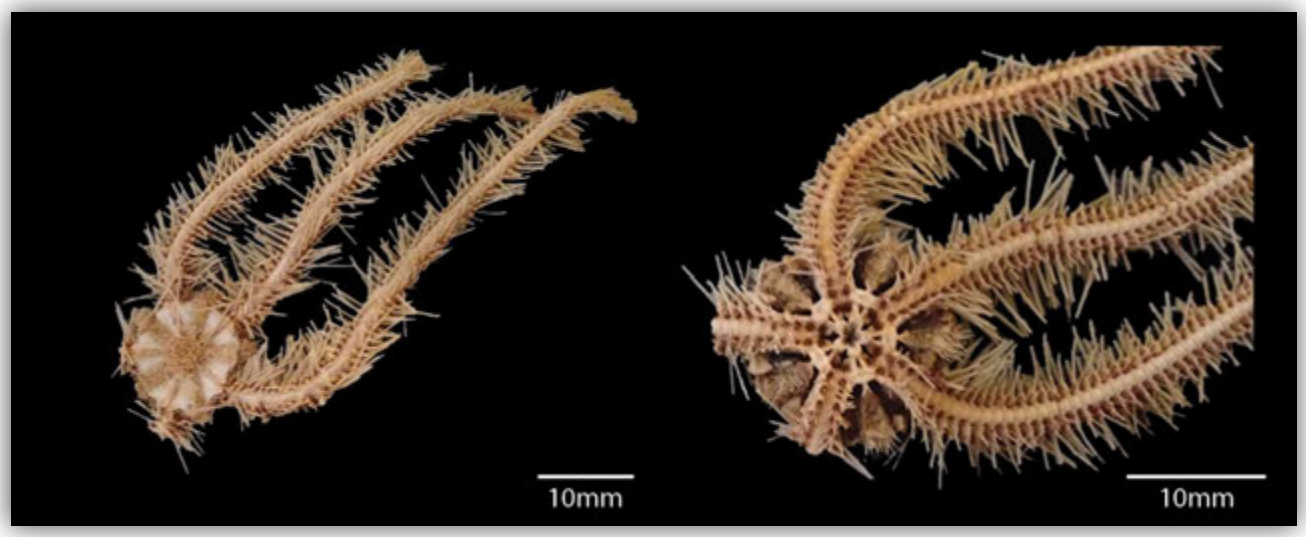

Figure 6.195. Dorsal (left) and ventral (right) views of *Ophiothrix* (*Acanthophiothrix*) *proteus* (SAMC A23264).

***Ophiothrix (Acanthophiothrix) purpurea* Von Martens, 1867**

Figs 6.196 and 6.197.

Ophiothrix purpurea Von Martens, 1867b: 346; Döderlein, 1896: 296, pl. 14, fig.12, pl. 17, figs 23-23a; Koehler, 1905a: 102; Clark, 1915a: 277; Koehler, 1922b: 261, pl. 58, figs 3-4, pl. 101, fig. 6; Vine, 1986: 195.
Ophiothrix fallax De Loriol, 1893a: 47-48, pl. 25, fig. 2.
Ophiothrix lorioli Döderlein, 1896: 297, pl. 14, fig. 13a, b, pl. 17, fig. 24a, b.
Placophiothrix purpurea: Clark, H.L., 1939: 86-87; Clark and Spencer Davis, 1966: 599.
Ophiothrix (*Acanthophiothrix*) *purpurea*: Clark and Rowe, 1971: 86-87, 112, figs 35d, 36, pl. 15, figs 4, 11; Devaney, 1974: 141-142; Cherbonnier and Guille, 1978: 148-149, pl. 5, figs 5-6, fig. 61: 5-6; Sloan *et al.*, 1979: 103; Humpreys, 1981: 23; Guille and Vadon, 1985: 63; Marsh, 1986: 71; Liao and Clark, 1995: 241; Rowe and Gates, 1995: 424-425; Price and Rowe, 1996: 75; Putchakarn and Sonchaeng, 2004: 422; Olbers *et al.*, 2015: 101, pl. 5C, D.

Diagnosis *- adapted from Clark and Rowe (1971) and Cherbonnier and Guille (1978).*
D.D. up to 17mm. Disc pentagonal, dorsally scaled with armament of scattered tubercles and spinelets (long and short) interradially and between radial shields, smaller spinelets on disc margin. Disc ventrally with small spinelets. Radial shields triangular, naked, large, about two-thirds disc radius, more or less conspicuous dark purple stripe along distal edge, central area more or less variegated whitish and purple, distal edge concave. Oral shields elliptical, with sharp point on proximal side, much wider than long. Adoral shields contiguous. Genital slits almost reach disc margin, with genital plate from about half-way, genital papillae absent. Dorsal arm plates hexagonal, distal side convex, as long as wide or longer, consecutive plates in contact for less than one-third of their width. Ventral arm plates somewhat fan-shaped, distal side concave, proximal edge convex becoming straight, as long or longer than wide. Arm spines up to seven, mostly five, glassy, upper spines smooth becoming serrated, up to five times segment length, lower spines shorter and more serrated, lowest arm spine often very short with hooks. Tentacle pores large. Tentacle scale one, small, pointed. Colour in life dorsally varying shades of reds, pinks and whites, some with striking lines, arms with thin dark longitudinal line along length of arm both dorsally and ventrally, dorsal arm plates with some lateral whitish patches.

Distribution and habitat
Tanzania, Red Sea, Madagascar, Mascarene Basin, Aldabra, Seychelles, Australia (Rowe and Gates, 1995; Stöhr, 2007i), South Africa: Sodwana Bay (KZN) to Kosi Bay (KZN); depth range: 5-508m. Habitat: Epizoic on *Millepora* species, soft corals, gorgonians, sponges and crinoids.

Remarks
A distinctive feature of this species is the dark longitudinal lines on both dorsal and ventral arms.

Type material is in the Museum of Natural History at the University of Berlin (syntype: ZMB Ech 1331), type locality is Amboina, Indonesia (Rowe and Gates, 1995). For additional remarks, see Olbers *et al.* (2015), where this is also reported as a new record for South Africa.

Figure 6.196. Distribution of *Ophiothrix* (*Acanthophiothrix*) *purpurea* in South Africa.

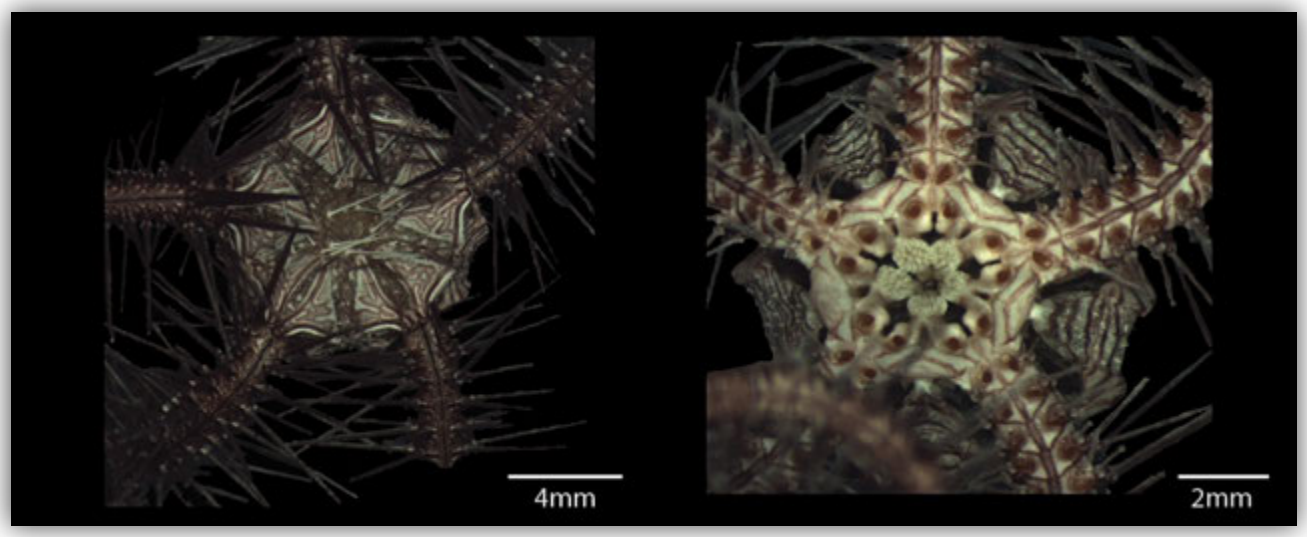

Figure 6.197. Dorsal (left) and ventral (right) views of *Ophiothrix* (*Acanthophiothrix*) *purpurea* (RMCA MT2185).

Ophiothrix (Ophiothrix) aristulata Lyman, 1879

Fig. 6.198 and 6.199.

Ophiothrix aristulata Lyman, 1879: 50-51, pl. 15, figs 421-424; Lyman, 1882: 223-224, pl. 21, figs 9-12; Bell, 1905: 258; Clark, 1915a: 269; Koehler, 1922b: 205-208, figs 1-3; Clark, 1923: 336-337; Mortensen, 1933c: 336-337; Clark, A.M., 1952: 200; Clark, 1966: 646.
Ophiothrix aristulata var. *investigatoris* Koehler, 1897: 361-363, pl. 9, figs 72, 73.
Ophiothrix megaloplax: Koehler, 1930: 170-172, pl. 9, figs 8, 9.
Placophiothrix aristulata: Clark, H.L., 1939: 86.
Ophiothrix (*Ophiothrix*) *aristulata*: Clark, 1974: 466-467, fig. 11c, d; Clark and Courtman-Stock, 1976: 101, 110, 112, 142, figs 111, 115; Rowe and Gates, 1995: 420.

Diagnosis *- adapted from Clark (1974) and Clark and Courtman-Stock (1976).*
D.D. up to 16mm, D.D./A.L. = 1/9. Disc pentagonal, dorsally scaled with armament of spinelets both dorsally and ventrally, including between radial shields. Radial shields triangular, naked, large, distal edge concave, not reaching centre of disc. Genital slits not reaching disc margin, distinct genital plate, genital papillae absent. Oral shields diamond-shaped with rounded corners, proximal point blunt, much wider than long. Adoral shields may or may not be contiguous. Dorsal arm plates fan, rhomboidal or diamond-shaped, distal side strongly convex, as long as wide or slightly wider, consecutive plates in contact for less than one-third of their width. Ventral arm plates square or rectangular, mostly wider than long, distal edge convex becoming straight or slightly concave. Arm spines up to ten, upper spines serrated, up to six times the segment length, lower spines short, often just stumps. Tentacle pores large, tentacle scales single, relatively small, square. Colour in life grey, red, pink, arms similar, red or pink, light white longitudinal line sometimes with pink or red stripes bordering the line.

Distribution and habitat
Australia, New Zealand (Rowe and Gates, 1995; Mah *et al.*, 2009), South Africa: off Orange River (NC) to Sodwana Bay (KZN); depth range: 55-620m.
Habitat: Stones, coral rock, sand, clay and shells.

Remarks
Koehler (1922b), Mortensen (1933c) and Clark (1923) suggested that a number of authors have misidentified *Ophiothrix* (*Ophiothrix*) *aristulata* as *Ophiothrix triglochis* or *vice versa*, but maintained

that *aristulata* was easily distinguished by its arm spines, which are seldom stout, and that this species occurs deeper than *O. triglochis*. See additional comments under *Ophiothrix fragilis* var. *triglochis* (below).

The type material is at the Natural History Museum (holotype: NHMUK 1882.12.23.194), the Museum of Comparative Zoology (paratype: MCZ OPH-2270) and the type locality is south of Cape Point, depth 275m (Rowe and Gates, 1995).

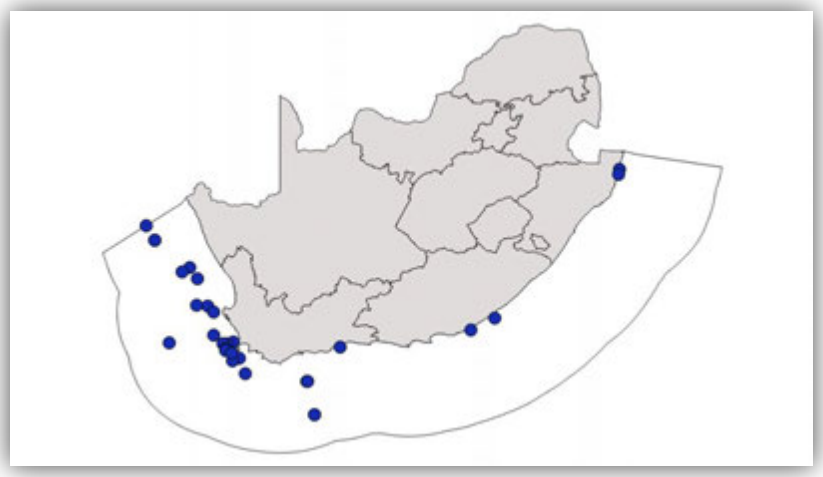

Figure 6.198. Distribution of *Ophiothrix* (*Ophiothrix*) *aristulata* in South Africa.

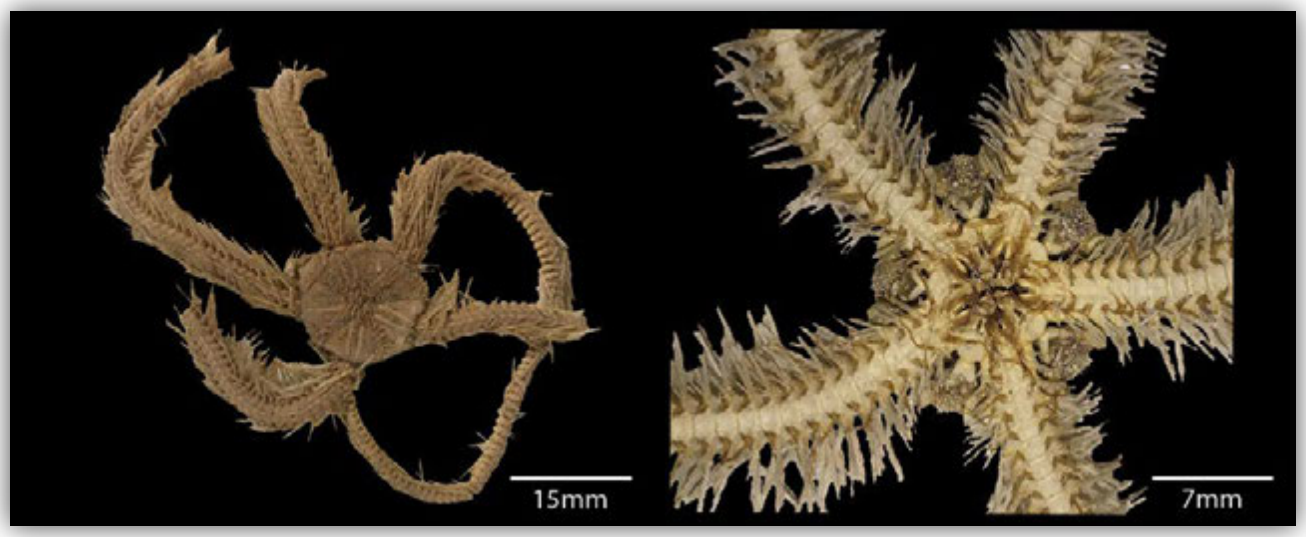

Figure 6.199. Dorsal (left) and ventral (right) views of *Ophiothrix* (*Ophiothrix*) *aristulata,* SAMC A7516 (dorsal); SAMC A7536 (ventral).

***Ophiothrix (Ophiothrix) echinotecta* Balinsky, 1957**

Figs 6.200 and 6.201.

Ophiothrix (*Ophiothrix*) *echinotecta* Balinsky, 1957: 16-17, fig. 6, pl. 3, figs 9, 10; Kalk, 1958: 198; Macnae and Kalk, 1969: 99, 106, 129; Clark and Rowe, 1971: 84-85, 109; Clark and Courtman-Stock, 1976: 112, figs 112, 116, 101, 143; Tortonese, 1980: 122; Humpreys, 1981: 23; Olbers *et al.*, 2015: 101-102, pl. 5E, F.
Ophiothrix echinoteta: Mbongwa, 2013: 16 (*lapsus calami*).

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 8mm. Disc round, covered with stumps with density on radial shields being slightly less, stumps bicuspid, tricuspid and multifid, stumps reaching ventral interradial areas. Radial shields length about half disc radius. Oral shields diamond-shaped, twice as wide as long. Adoral shields narrow and contiguous. Genital slits reaching half-way up to margin with distinct genital plate adjacent to slit, genital papillae absent. Dorsal arm plates fan-shaped with single, short rugose stump between many successive plates, narrowly contiguous. Ventral arm plates slightly wider than long with straight or slightly concave distal edge. Arm spines up to ten, serrated for total length, glassy, middle spine longest, *c.* three times segment length, upper spines shorter with uppermost spine being short stumps, lowermost being transformed into a hook. Tentacle scale one, small, may bear one or two sharp points at tip. Colour in life, dorsal disc light and dark greens, greys and blues. Radial shields variegated white and green, slightly darker than remaining disc, dorsal arm plates sometimes with dark transverse line or light chevron on distal side, ventral side slightly lighter.

Distribution and habitat
Mozambique, Madagascar, Tanzania, Kenya, Somalia (Balinsky, 1957; Clark and Rowe, 1971; Tortonese, 1980; Humpreys, 1981), South Africa: Isipingo (KZN) to Bhanga Nek (KZN); depth range: 0-64m.
Habitat: In rock hollows and under echinoids *Echinometra mathaei* and *Stomopneustes variolaris* (Balinsky, 1957), also on coarse sand, gravel, shell debris, stones and sponges.

Remarks
Olbers *et al.* (2015) noted that this species was the most characteristic South African *Ophiothrix*, due to the rugose stumps present on many successive dorsal arm plates.

Type specimens are in the Iziko South African Museum (holotype: SAMC A22355 and paratype: SAMC A22356; examined) and the type locality is Lighthouse Rocks, Inhaca Island, Mozambique, depth 0m.

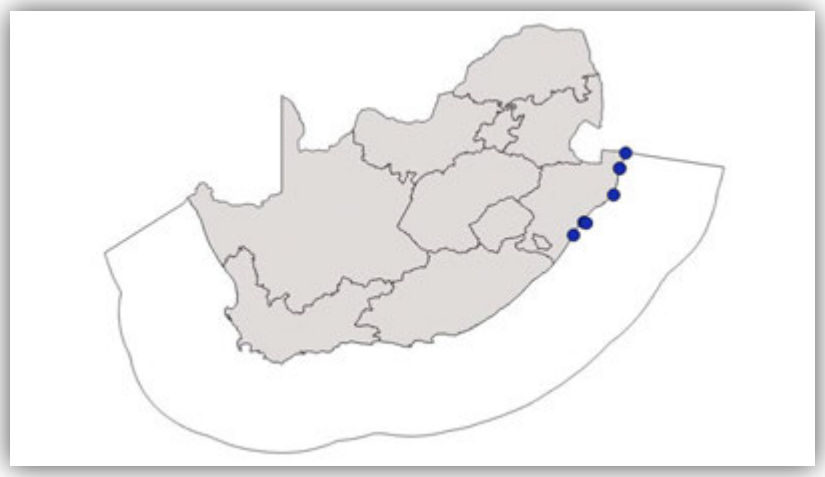

Figure 6.200. Distribution of *Ophiothrix* (*Ophiothrix*) *echinotecta* in South Africa.

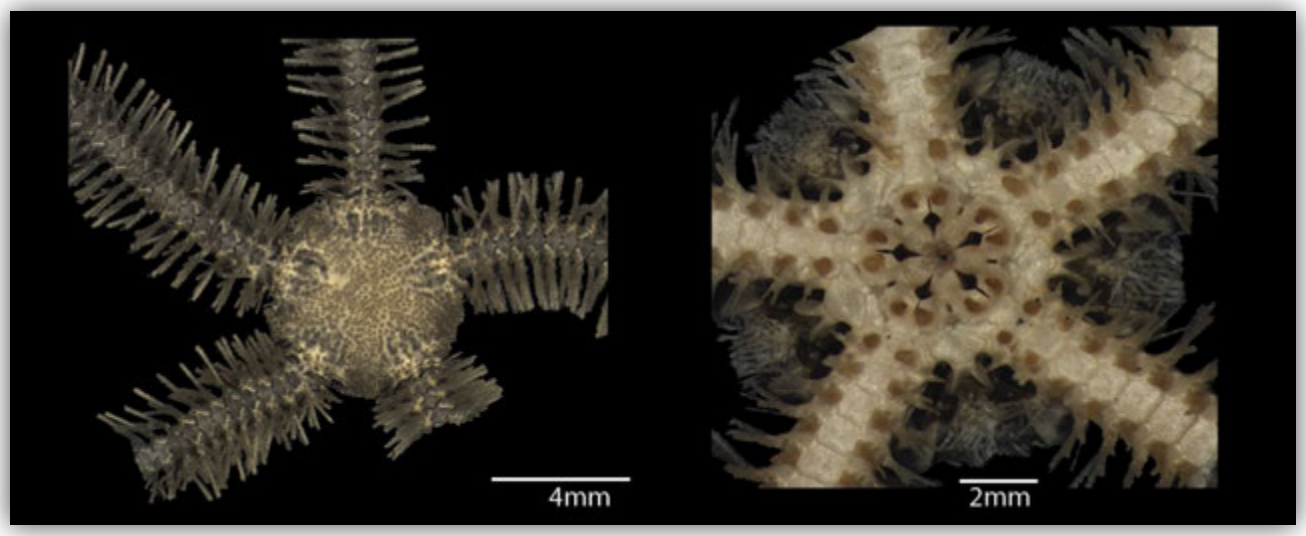

Figure 6.201. Dorsal (left) and ventral (right) views of *Ophiothrix* (*Ophiothrix*) *echinotecta* (RMCA MT2257).

Ophiothrix (Ophiothrix) foveolata Marktanner-Turneretscher, 1887

Figs 6.202 and 6.203.

Ophiothrix foveolata Marktanner-Turneretscher, 1887: 313, pl. 13, figs 32, 33; Koehler, 1905a: 76-77; Clark, 1915a: 280; Koehler, 1922b: 238-239, pl. 47, figs 4-7, pl. 98, fig. 6; Koehler, 1930: 140; Clark and Spencer Davis, 1966: 599; Clark, 1966: 647; Clark and Rowe, 1971: 84, 85, 110, pl. 15, fig. 3; Day, 1974: 94; Putchakarn and Sonchaeng, 2004: 423; Mbongwa, 2013: 16; Olbers *et al.*, 2015: 102, 104, pl. 6A, B.
Ophiothrix insidiosa Koehler, 1898b: 92-93, pl. 4, figs 34-36.
Ophiothrix poecilodisca Clark, 1915a: 276-277, pl. 13, fig. 5; Clark, 1923: 341.
Placophiothrix foveolata: Balinsky, 1957: 20, pl. 4, fig. 15; Kalk, 1958: 207, 214; Macnae and Kalk, 1962: 111; Macnae and Kalk, 1969: 102, 106, 130.
Ophiothrix (*Ophiothrix*) *foveolata*: Day, 1969: 184; Clark and Courtman-Stock, 1976: 101, 112, 143-144, fig. 118.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*
D.D. up to 13mm. Disc round, sparsely covered in scales and some scattered small granules, if any at all, though peripherally some scattered large trifid stumps, disc scales moderately large. Radial shields triangular, naked, more than two-thirds disc radius, single row of scales between radial shields. Oral shields broad diamond-shaped, much wider than long. Adoral shields moderate in size, may or may not be contiguous. Genital slits half-way to disc margin, genital papillae absent, distinct genital plate. Dorsal arm plates fan-shaped, distal edge convex, consecutive plates in contact for less than half their width. Ventral arm plates square or rectangular, wider than long, distal edge concave, proximal edge slightly convex or straight distally. Arm spines up to eight, glassy, serrated, longest 4-5 times segment length, some spines with dark longitudinal bands and some with clavate tips. Tentacle scale one, small, tapering. Colour in life ranging from orange, light brown to violet, young specimens may be bright red, radial shields whitish, patterned with dark purple lines and pinkish patches, adradial edges of radial shields may have dark lines. Arms transversed with same striking dark lines as on disc.

Distribution and habitat
Mozambique, Madagascar, Thailand (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Clark, 1980; Putchakarn and Sonchaeng, 2004; Stöhr, 2011b), South Africa: Amanzimtoti (KZN) to Kosi Bay (KZN); depth range: 9-305m.
Habitat: Coral reefs, sponges, under dead coral blocks, rock crevices and in *Cymodocea* beds.

Remarks

In addition to recording *Ophiothrix* (*Ophiothrix*) *foveolata* as a new species for South Africa, Olbers *et al.* (2015) also recognised that *O.* (*Ophiothrix*) *foveolata* is similar to *Macrophiothrix propinqua,* with the exception of the radial shield size. The type material is in the Museum of Comparative Zoology (holotype: MCZ OPH-2476, paratype: MCZ OPH-3928), type locality is Zanzibar, depth unknown.

Figure 6.202. Distribution of *Ophiothrix* (*Ophiothrix*) *foveolata* in South Africa.

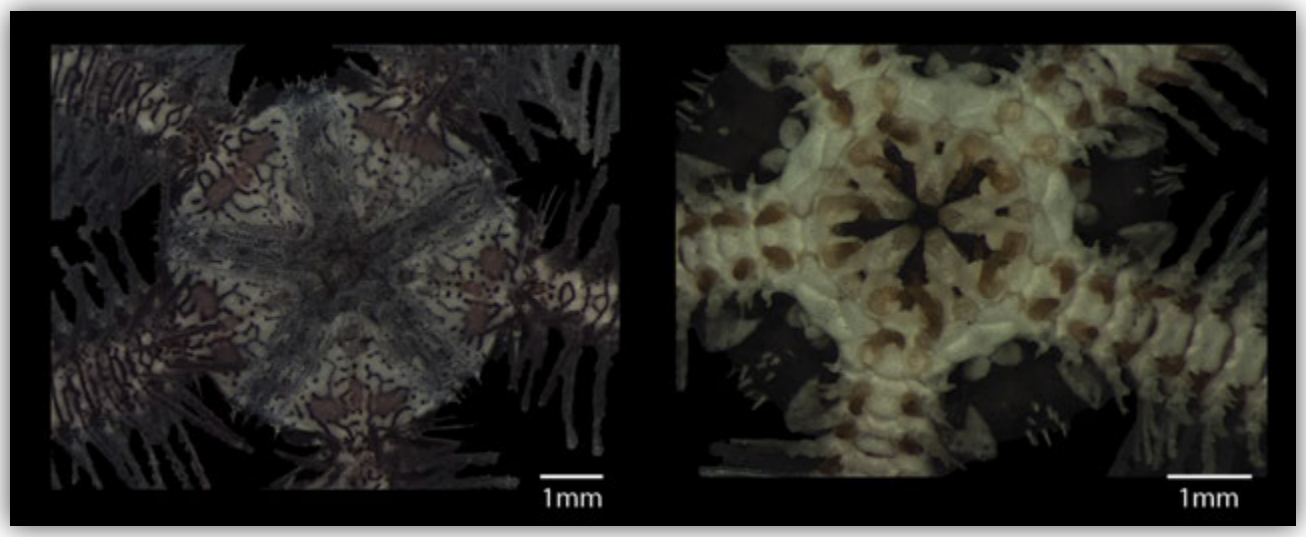

Figure 6.203. Dorsal (left) and ventral (right) views of *Ophiothrix* (*Ophiothrix*) *foveolata* (RMCA MT2174).

***Ophiothrix fragilis* Abildgaard in O.F. Müller, 1789**

Figs 6.204 and 6.205.

Asterias fragilis Abildgaard In: Müller, 1789: 28-29, figs 1-3, pl. 98.
Asterias pentaphylla Pennant, 1777: 51.
Ophiothrix fragilis: Müller and Troschel, 1842: 110; Koehler, 1908a: 635; Koehler, 1914b: 209-210; Clark, 1923: 337; Mortensen, 1927: 174-176, fig. 98; Mortensen, 1933c: 338; Madsen, 1970: 213-214, fig. 36c; Clark, 1974: 467-469; Clark and Courtman-Stock, 1976: 102, 112, 144-145, fig. 105, 113; Mbongwa, 2013: 16; Alva and Vadon, 1989: 829.

Diagnosis *- adapted from Clark (1974) and Clark and Courtman-Stock (1976).*
D.D. up to 20mm, D.D/A.L. = 1/5. Dorsal disc scales covered in thorny spinelets, stumps and spines, may be intermixed. Radial shields triangular, more than half disc radius (larger than *O. fragilis* var. *triglochis*), naked. Ventral interradial area of disc with spinelets, areas closest to oral shields naked. Oral shields diamond-shaped, with proximal lobe wider than long. Adoral shields may or may not be contiguous. Genital slits more than half to disc margin, genital plates distinct, genital papillae absent. Dorsal arm plates fan-shaped, sometimes wide as long, but often wider than long, distal edge convex, slightly contiguous. Ventral arm plates rectangular, distal edge distinctly concave, contiguous. Arm spines up to ten (usually seven), glassy, thorny over total length, not tapering, sometimes lowermost transformed into a hook, longest one not more than three times segment length. Tentacle scale single, small, usually with one tip, but sometimes two or three. Colour in life various combinations of greens, greys, browns, purples, yellows, pinks and reds, arms banded and often with dots associated with dorsal arm plates longitudinally along arms.

Distribution and habitat
European marine waters, Mediterranean Sea, North Sea, North East Atlantic (Stöhr and Hansson, 2010), South Africa: off Orange River (NC) to Kosi Bay (KZN); depth range: 0-148m.
Habitat: Among kelp, sand, shells, rock, limestone, gravel, sandstone and sponge.

Remarks
Endemic to the region, also being found in Namibia. Also see remarks on *Ophiothrix fragilis* var. *triglochis*.

Two types are in the Swedish Museum of Natural History, *Ophiothrix lusitanica*: SMNH-Type-1423 (syntype, type locality Setúbal harbour, Portugal) and *Ophiothrix rubra*: SMNH-Type-1437 (holotype, type locality sound between Faial and Pico, Portugal, depth 27m).

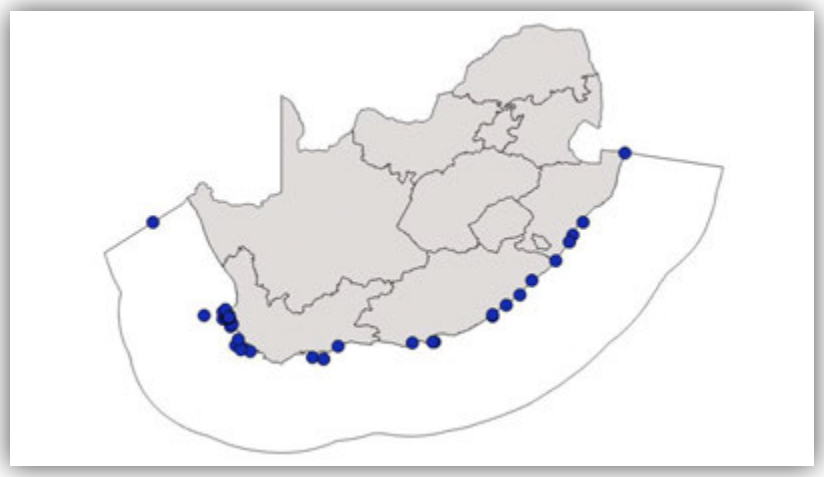

Figure 6.204. Distribution of *Ophiothrix fragilis* in South Africa.

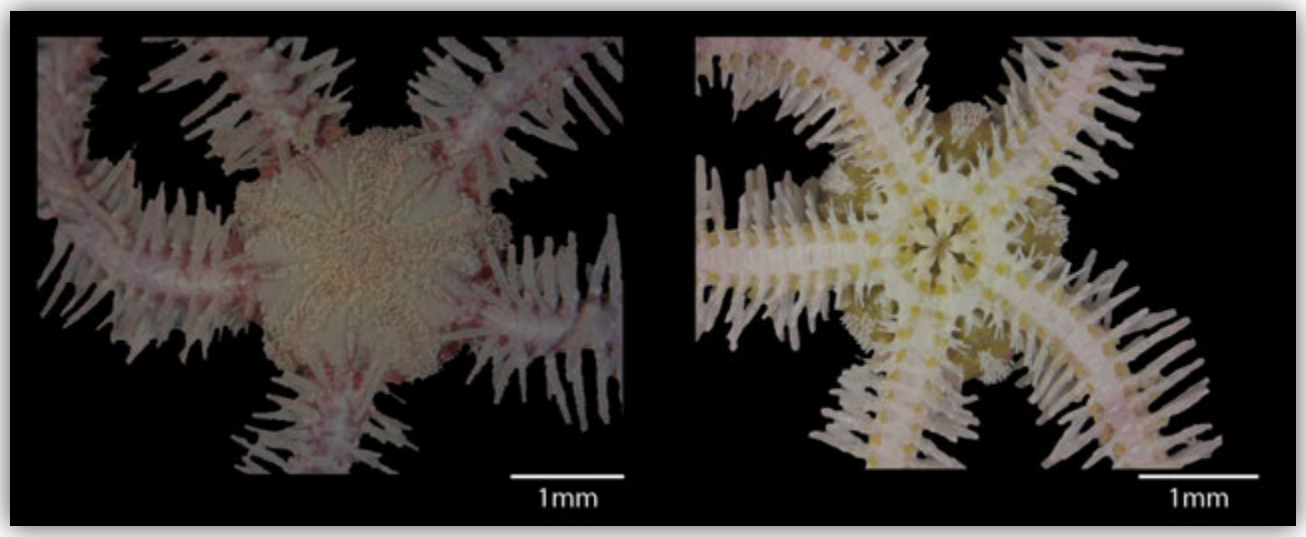

Figure 6.205. Dorsal (left) and ventral (right) views of *Ophiothrix fragilis* (SAMC A088480).

***Ophiothrix fragilis* var*. triglochis* Müller and Troschel, 1842**

Figs 6.206 and 6.207.

Ophiothrix triglochis Müller and Troschel, 1842: 114; Lütken, 1869: 59-60; Lyman, 1882; 218; Koehler, 1904b: 81-84, figs 41-45; Bell, 1905: 259; Koehler, 1908a: 635; Clark, 1923: 337-339; Mortensen, 1933c: 337-338; Stephenson *et al.*, 1937: 380; Bright, 1937a: 63; Stephenson *et al.*, 1938: 18; Eyre, 1939: 304; Stephenson, 1944; 317, 347; Clark, A.M., 1952: 201; Day *et al.*, 1952: 412; Day, 1959: 502, 544; Morgans, 1959: 303, 322; Morgans, 1962: 414, 422, 425; Day *et al.*, 1970: 80; Penrith and Kensley, 1970: 201, 206, 208, 234.
Ophiothrix fragilis var. *triglochis*: Stöhr, 2011c.

Diagnosis *- adapted from Clark (1923) and Clark and Courtman-Stock (1976).*
D.D. up to 20mm, D.D./A.L. = 1/5. Dorsal disc scales covered in spinelets, stumps and spines, never intermixed. Radial shields triangular, more than half disc radius (smaller than *O. fragilis*), covered in stumps, sometimes sparsely so. Ventral side of disc with spinelets, with interradial areas closest to oral shields naked. Genital slits extending more than half way to disc margin, genital plate distinct, genital papillae absent. Oral shields diamond-shaped with proximal lobe, wider than long. Adoral shields may or may not be contiguous. Arm spines up to ten (usually seven), glassy, thorny over total length, not tapering, sometimes lowermost transformed into a hook, longest one not more than three times segment length. Dorsal arm plates fan-shaped, sometimes wider than long, distal edge convex, slightly contiguous. Ventral arm plates rectangular, wider than long, distal edge distinctly concave, not always contiguous. Tentacle scale single, small, usually with one tip, but sometimes two or three. Arms may be banded green, grey, brown, purple or red.

Distribution and habitat
South Africa: off Orange River (NC) to Tugela Mouth (KZN), depth range: 0-348m.
Habitat: Sponges, sand, shell, coral, mud, broken *Lithothamnion*, rock and under stones.

Remarks
Endemic to South Africa (see Table 7.4).

Clark (1923) and Mortensen (1927) separated var. *triglochis* based on i) the disc not having spinelets in among the disc stumps, ii) radial shields more or less well covered by stumps, iii) radial shields smaller than in *fragilis*, iv) disc spines less thorny than in *fragilis*, v) dorsal arm plates wider than in *fragilis*, and vi) ventral arm plates shorter, wider and more widely separated that *fragilis.* Of the many

specimens examined, some determined by A.M. Clark, there appeared to be no consistent characters to separate these forms. The most reliable difference should be stumps on the radial shields, with *fragilis* being naked or having few stumps, while *triglochis* can be covered to a varying degree by stumps. The stumps, however, also appeared to be an unreliable characteristic. In order to prove separation of *O. fragilis* var. *triglochis* and *O. fragilis*, a molecular study should be undertaken to compare the differences between a) the subtropical and temperate species within South Africa, and b) South African specimens and European specimens.

The type material is in the Museum of Comparative Zoology (syntype: MCZ OPH-2448), type locality is Port Natal (Durban), South Africa, depth unknown.

As in the remarks for *Ophiothrix* (*Ophiothrix*) *aristulata*, Koehler (1922b), Mortensen (1933c) and Clark (1923) suggested a number of authors may have misidentified *O. aristulata* as *O. triglochis,* or *vice versa*, but they maintained that *O. triglochis* was easily distinguished by its long arm spines and occurs in shallower depths than *aristulata*. However, the arm spines in *triglochis* have been reported as no longer than three arm segments, while the depth range of *aristulata* is 55-620m, which overlaps with *triglochis* (0-130m). In this study, the three South African species (*aristulata*, *fragilis* and *triglochis*) are all treated as separate species. It is recommended that these three species should be revised to establish if they are distinct.

Figure 6.206. Distribution of *Ophiothrix fragilis* var. *triglochis* in South Africa.

Figure 6.207. Dorsal (left) and ventral (right) views of *Ophiothrix fragilis* var. *triglochis* (SAMC A084242).

Family OPHIACANTHIDAE Ljungman, 1867

Diagnosis *- adapted from Mortensen (1927), Clark and Courtman-Stock (1976), Paterson (1985), O'Hara and Stöhr (2006) and Martynov (2010).*
Disc covered to a varying degree by spines, stumps or granules, which may or may not conceal the scales. Single unpaired infradental oral papillae with three or more smaller oral papillae on either side in a continuous series, mostly pointed, papilliform or sometimes spine-like. Within this series, papillae may arise from the jaws. Teeth sometimes present. Arms flexible horizontally or dorsoventrally, sometimes with vertebrae being restricted, giving a monoliliform appearance. Arm spines usually long and serrated to varying degrees. Tentacle pores usually small. Tentacle scales usually single. Most species found in deep-water, often clinging to corals, sponges or gorgonians.

This family is known to have many unresolved taxonomic problems and ambiguities and despite many attempts to resolve these (Verrill, 1899a; Matsumoto, 1915; Matsumoto, 1917; Paterson, 1985; O'Hara and Stöhr, 2006; Martynov, 2010) still, no classification scheme appears to have been accepted in its entirety.

Genus Ophiacantha **Müller and Troschel, 1842**

Diagnosis *- adapted from Mortensen (1927), Clark and Courtman-Stock (1976) and Devaney (1978).*
Disc not restricted interradially, covered by spines, stumps, granules or a combination of these, which may or may not conceal the scales. Radial shields inconspicuous, separated, bar-like, but only distal ends visible. Oral shields broad-rhombic, adoral shields relatively large and usually broadly contiguous, single unpaired infradental oral papilla with three or more smaller oral papillae either side in a continuous series, mostly pointed, papilliform, and sometimes spine-like, often distalmost papillae enlarged. Teeth in single series, pointed. Dorsal arm plates small, fan-shaped or triangular with distal side convex, plate becoming rhombic distally. Ventral arm plates pentagonal or bell-shaped with distal side convex, not usually contiguous. Arm spines erect, often long, sometimes rugose, tapering, pointed. Tentacle pores small. Tentacle scales usually single, papilliform.

Ophiacantha baccata Mortensen, 1933

Figs 6.208 and 6.209.

Ophiacantha baccata Mortensen, 1933c: 319-322, figs 40, 41, pl. 19; Clark and Courtman-Stock, 1976: 104, 121, 167, figs 170, 181; Clark, 1977: 135.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 6.5mm, D.D./A.L. = *c.*1/6. Disc armed above and below with small trifid and multifid thorny stumps. Radial shields indistinct with distal ends naked. Oral shields diamond-shaped, with point on proximal side, sunken in the middle. Adoral shields with narrow distal lobe, broadly contiguous. Oral papillae three each side of broad infradental papilla, outermost broadest. Arms monoiliform. Dorsal arm plates diamond-shaped, equally wide as long, widely separated by lateral arm plates. Ventral arm plates pentagonal, all plates smooth. Arm spines up to seven, slender, rugose, long, up to three times segment length. Tentacle scale small, single, elongated and rugose. Colour in life light straw, numerous dark spots scattered on disc, darks spots often have single, darker stump, arms lightly banded.

Distribution and habitat
Mozambique (Mortensen, 1933c; Clark and Courtman-Stock, 1976), South Africa: Cape Town (WC) to Kosi Bay (KZN); depth range: 9-900m.
Habitat: Sand, shells and stones.

Remarks
Mortensen's Pacific Expedition collection of 1933 is lodged at the Natural History Museum of Denmark, which includes syntypes ZMUC OPH-75 and ZMUC OPH-359, while in the Iziko South African Museum, additional syntypes are housed (labelled as 'cotypes') (SAMC A22372), which were examined during this study. The type locality is Durban, depth 400-450m.

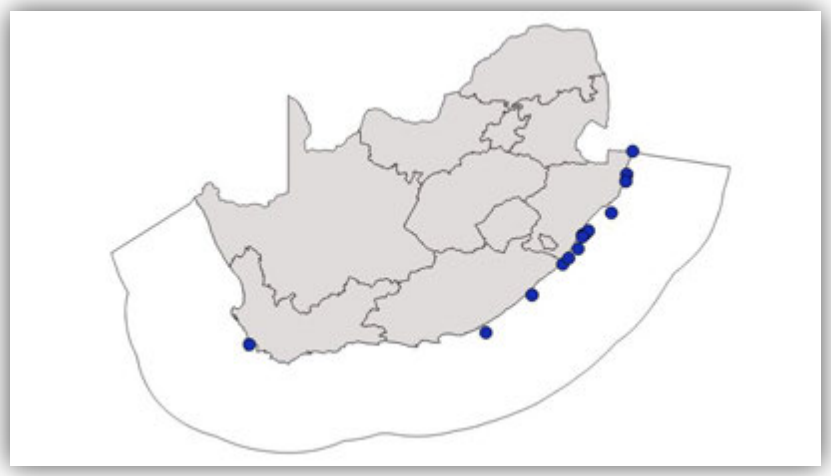

Figure 6.208. Distribution of *Ophiacantha baccata* in South Africa.

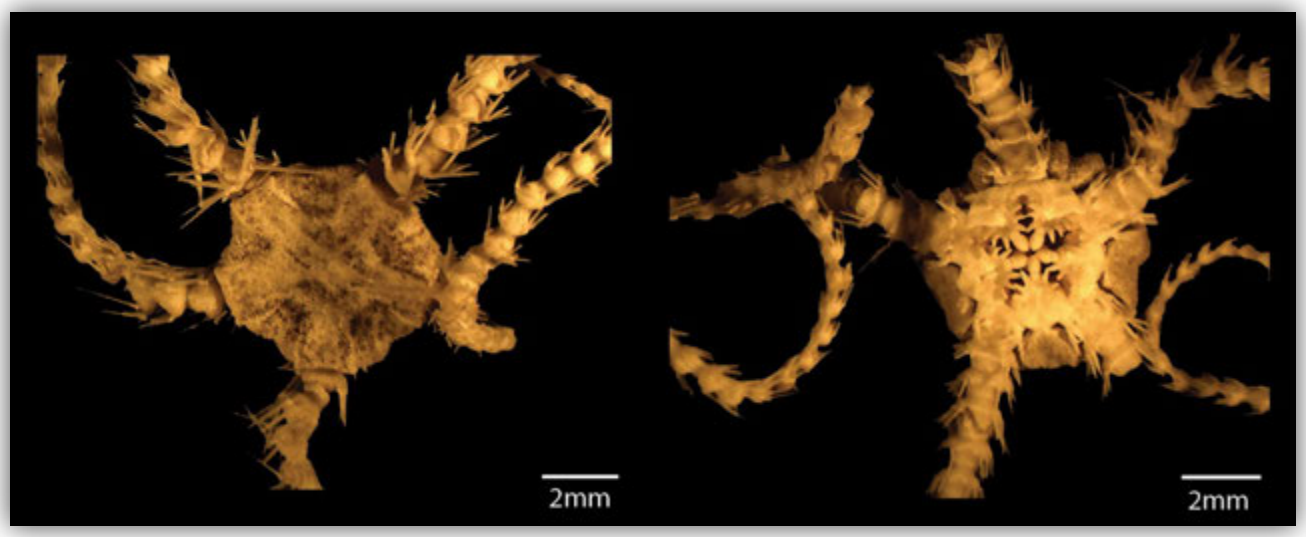

Figure 6.209. Dorsal (left) and ventral (right) views of *Ophiacantha baccata* (SAMC A084245).

***Ophiacantha nerthepsila* H.L. Clark, 1923**

Figs 6.210 and 6.211.

Ophiacantha nerthepsila Clark, 1923: 319-322, fig. 1, pl. 19, figs 3, 4; Mortensen, 1933c: 316-317, fig. 37; Day *et al.*, 1970: 80; Clark and Courtman-Stock, 1976: 104, 121, 168, fig. 173.
Ophiacantha barracoutae Koehler, 1923: 3-5, figs 1-3.

Diagnosis *- adapted from Mortensen (1933c).*
D.D. up to 7mm, D.D./A.L. = *c.*1/3-4. Disc round, disc armed above with granules and scattered spinelets, sometimes extending onto ventral interradial areas. Radial shields widely separated, *c.* width of arm, mostly covered in granules and spines, with only small triangular portion of each exposed. Disc margin vertical. Oral shields broad diamond-shaped, sunken. Adoral shields with no distal lobe, contiguous. Oral papillae three each side of broad infradental papilla, outermost broadest. Teeth becoming square deep in mouth. Dorsal arm plates fan-shaped or triangular, distal edge convex, may be bell-shaped if successive arm plates are sinuous, narrowly contiguous, if at all. Ventral arm plates pentagonal, distal side straight. Arm spines up to seven, uppermost longest, at most three times segment length, usually twice segment length. Tentacle scale small, single, spiniform but blunt. Colour pale brown, lighter below, dorsal interradial area with faint white patches surrounded by darker brown, arms banded.

Distribution and habitat
South Africa: Elands Bay (WC) to Mfafazana (KZN); depth range: 22-900m.
Habitat: Rock, sand and mud.

Remarks
Endemic to South Africa (see Table 7.4). Distribution here extended both east and west within South Africa (see Table 7.3). The Iziko South African Museum has a type specimen, SAMC A6437 (examined), accessioned as the paratype, but according to Clark (1923) (original description) this accession number is the holotype. Additional types available include: paratypes: SAMC A7478 (examined) and ZMUC OPH-221. The type locality is Riet Point, Eastern Cape, depth 42m.

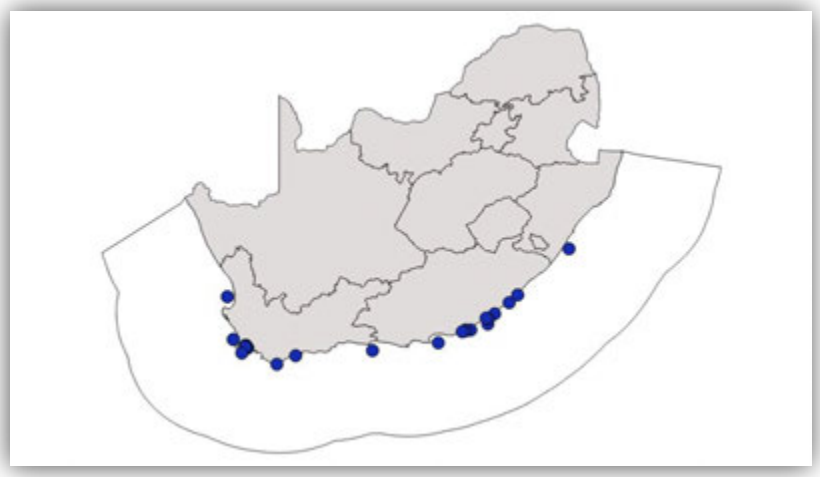

Figure 6.210. Distribution of *Ophiacantha nerthepsila* in South Africa.

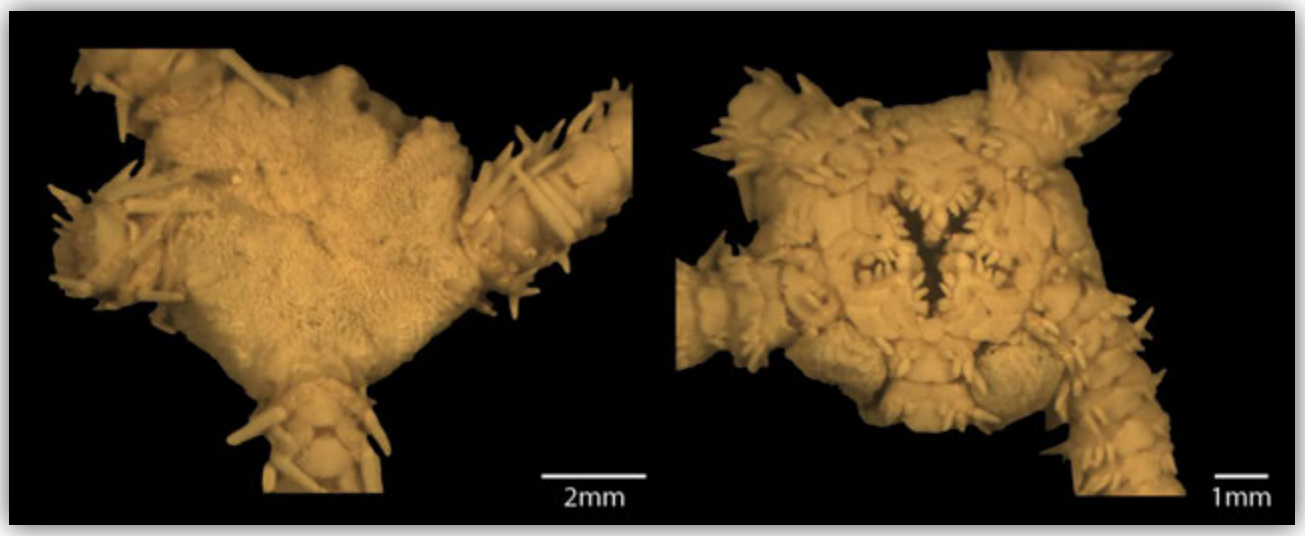

Figure 6.211. Dorsal (left) and ventral (right) views of *Ophiacantha nerthepsila* (SAMC A084235)

***Ophiacantha scutigera* Mortensen, 1933**

Figs 6.212 and 6.213.

Ophiacantha scutigera Mortensen, 1933c: 317-319, figs 38, 39, pl. 19, figs 6, 7; Clark and Courtman-Stock, 1976: 104, 121, 168, figs 174, 179.

Diagnosis *- adapted from Mortensen (1933c).*

D.D. up to 6mm, D.D./A.L. = 1/6. Disc covered with tubercles or low, blunt stumps with some scattered slender spinelets, becoming longer towards centre of disc. Radial shields short and small, tapering proximally, separated by less than arm width. Disc margin vertical, disc scales distinct, some tubercles present. Ventral interradial areas with medium to coarse scaling, with one or two scattered tubercles. Oral shields rhombic or oval, with proximal point. Oral papillae three, sometimes four, may be concaved, outermost papilla sometimes slightly enlarged, broader infradental papilla. Teeth present, *c.* 5-6, similar in shape to infradental papillae. Adoral shields contiguous. Dorsal arm plates triangular, twice as wide as long, with distal side convex, not contiguous, separated by lateral arm plate. Ventral arm plates fan-shaped, not contiguous, separated by lateral arm plates. Lateral and ventral arms plates with transverse concentric striations. Arm spines up to ten proximally, upper spines long and

smooth, lower spines slightly serrated, spiniform, *c.* four times segment length on basal segments then two times on remaining arm. Uppermost arm spines on both sides of the arm almost meet at dorsal midline. Arms not monoiliform. Tentacle scale single, rounded, fairly large. Colour light grey or brown with small dark spots around radial shields with dark patches on distal edges and dark spots along dorsal midline of arms.

Distribution and habitat

South Africa: Amanzimtoti (KZN) to Leven Point (KZN); depth range: 164-450m.
Habitat: No information available.

Remarks

Endemic to South Africa (see Table 7.4). Distribution here extended north and south within KwaZulu-Natal (see Table 7.3). The type material in the Iziko South African Museum was labelled as 'cotype' (SAMC A22368; examined). Additional syntypes were located in the Natural History Museum of Denmark (ZMUC OPH-358 and ZMUC OPH-263). The type locality is off Durban, depth 219m.

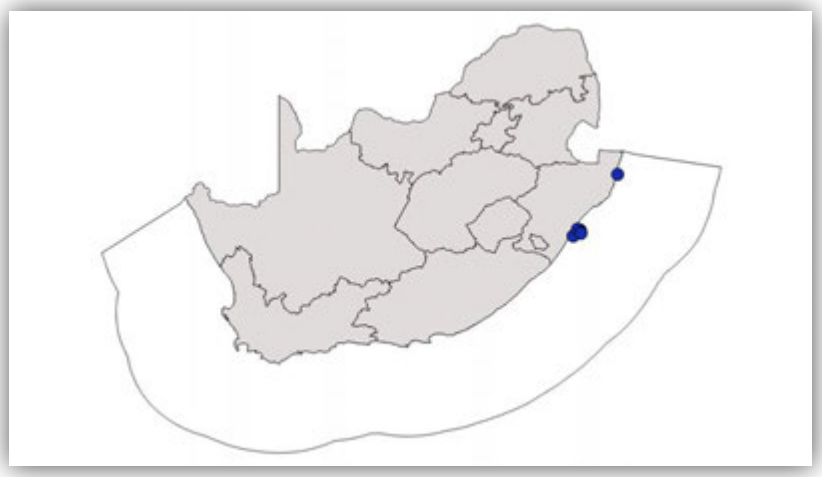

Figure 6.212. Distribution of *Ophiacantha scutigera* in South Africa.

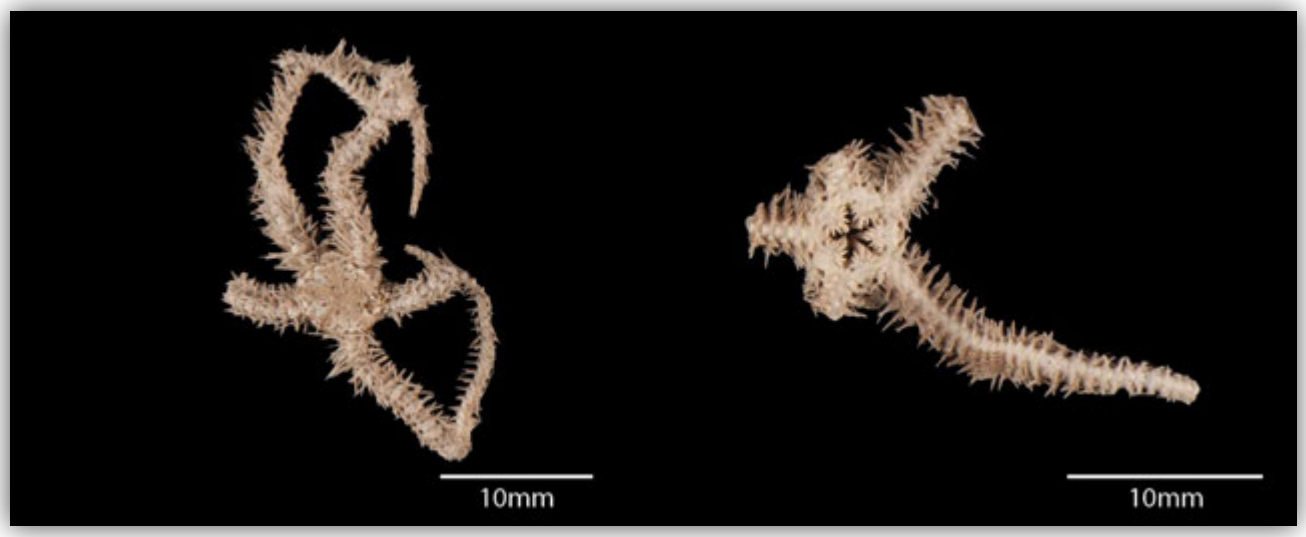

Figure 6.213. Dorsal (left) and ventral (right) views of *Ophiacantha scutigera* (ZMUC OPH-263).

Ophiacantha striolata Mortensen, 1933

Figs 6.214 and 6.215.

Ophiacantha striolata Mortensen, 1933c: 322-324, figs 42, 43; Clark, 1974: 442; Clark and Courtman-Stock, 1976: 105, 121, 168-169, figs 169, 175, 180; Clark, 1977: 135.

Diagnosis *- adapted from Mortensen (1933c).*

D.D. up to 3mm, D.D./A.L. = 1/4. Disc covered with small, thorny, trifid stumps. Radial shields mostly covered in same armament, with only distal ends visible. Ventral interradial areas covered in same stumps, except in areas closest to oral shields. Oral shields almost triangular, with slight distal lobe. Adoral shields fairly narrow, contiguous, with narrow distal lobe. Oral papillae three, all similar and narrow, conspicuously smaller than infradental papillae. Dorsal arm plates small, triangular, distal side convex, not contiguous. Ventral arm plates fan-shaped, not contiguous, separated by lateral arm plates, first ventral arm plate narrow, longer than wide and distal edge strongly convex. All arm plates having transverse concentric striations. Arm spines up to eight, deeply serrated, slender, longest being twice segment length, distally spines nearly smooth except for lowermost, which have fine serrations. Arms not monoiliform. Tentacle scale single, pointed, with furrow on upper side.

Distribution and habitat

South Africa: Cape Town (WC) to Sodwana Bay (KZN); depth range: 84-650m.
Habitat: Fine khaki sand and gravel.

Remarks

Endemic to South Africa (see Table 7.4). Whereabouts of the holotype is unknown, but a syntype is in the Natural History Museum of Denmark (ZMUC OPH-271), depth unknown.

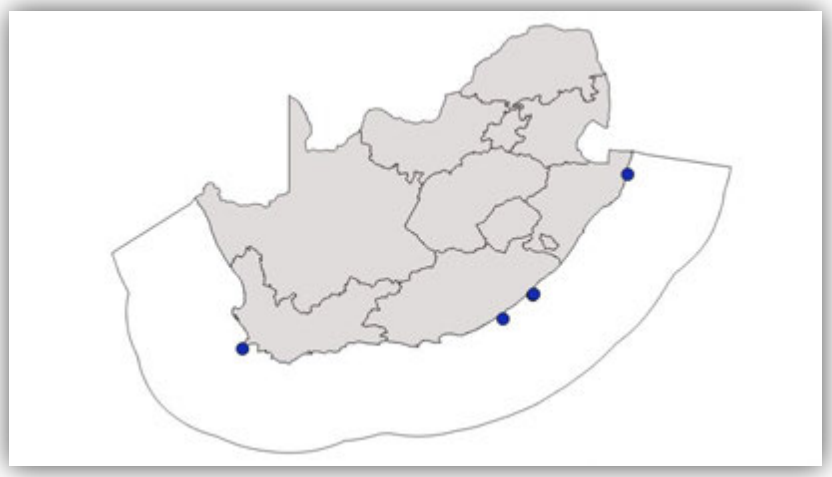

Figure 6.214. Distribution of *Ophiacantha striolata* in South Africa.

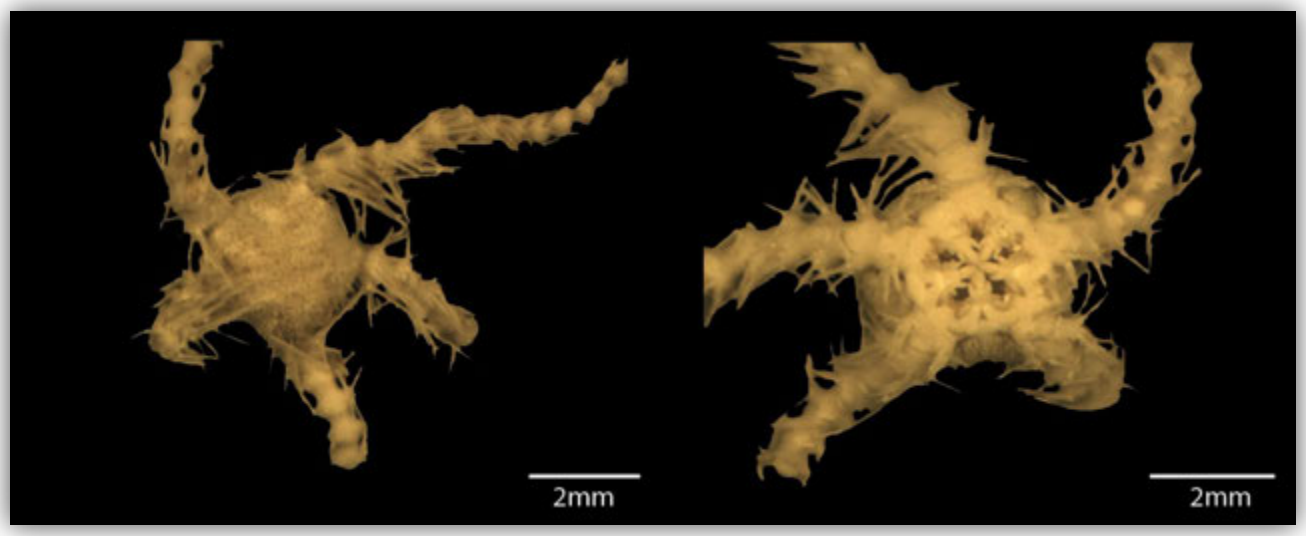

Figure 6.215. Dorsal (left) and ventral (right) views of *Ophiacantha striolata* (SAMC A084241).

Genus Ophiolimna Verrill, 1899

Diagnosis *- adapted from Verrill (1899b).*
Disc scales and radial shields concealed by granules and spines. Jaws more or less granulated. Arm spines seven or eight, nearly smooth, placed obliquely on distal portion of lateral arm plates, not strongly divaricate or spreading.

Ophiolimna perfida (Koehler, 1904)

Figs 6.216 and 6.217.

Ophiolimna perfida: Koehler, 1922b: 64-66, pl. 9, figs 7-9, pl. 92, fig. 6; Clark, 1977: 139-140.
Ophiacantha perfida Koehler, 1904a: 118-120, pl. 23, figs 5, 6; Clark, 1915a: 204.
Ophiacantha lambda Clark, 1911: 231-232, fig. 108; Clark, 1915a: 199.

Diagnosis *- adapted from Clark (1911) and Clark (1977).*
D.D. up to 12mm, D.D./A.L. = 1/6. Disc covered with small, elongated granules. Radial shields mostly covered in same armament, with distal ends bare and visible. Ventral interradial areas covered in same granules up to oral shields, less dense than dorsal side, jaws also covered in coarse granules. Oral shields almost oval, wider than long. Adoral shields covered in granules, contiguous. Oral papillae four, distalmost much broader. Infradental papillae blunt, similar in size to first three oral papillae. Teeth round, larger than infradental. Genital slits small. Dorsal arm plates fan-shaped, convex distally, not contiguous. Ventral arm plates fan-shaped to pentagonal, with distal edge convex, not contiguous, wider than long. Arm spines up to five, slender, tapering, smooth, uppermost spine longest, three times segment length. Tentacle scale single, oval, fairly large.

Distribution and habitat
Southern Japan to Indonesia (Clark, 1977), South Africa: Sodwana Bay (KZN); depth range: 411-1280m.
Habitat: Fine sand and mud.

Remarks
Only a single damaged specimen was available for examination in the Iziko South African Museum collection. The holotype whereabouts is unknown, but some additional type material was located in the Museum of Comparative Zoology (MCZ OPH-1986 (Indonesia) and MCZ OPH-3212 (Japan)).

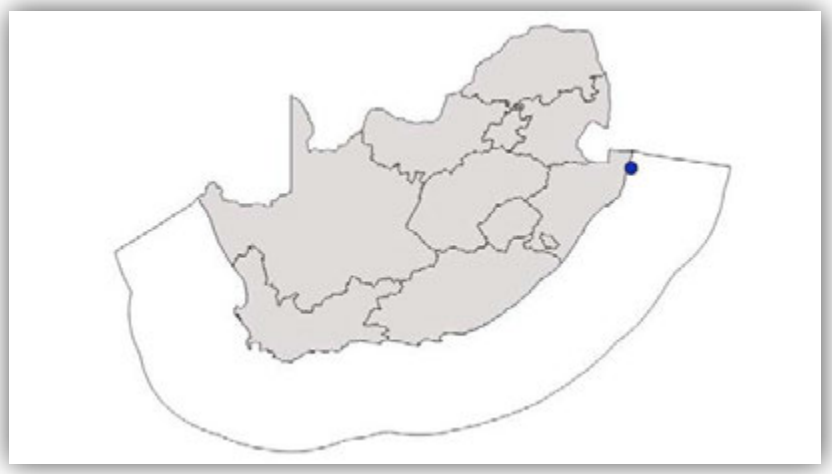

Figure 6.216. Distribution of *Ophiolimna perfida* in South Africa.

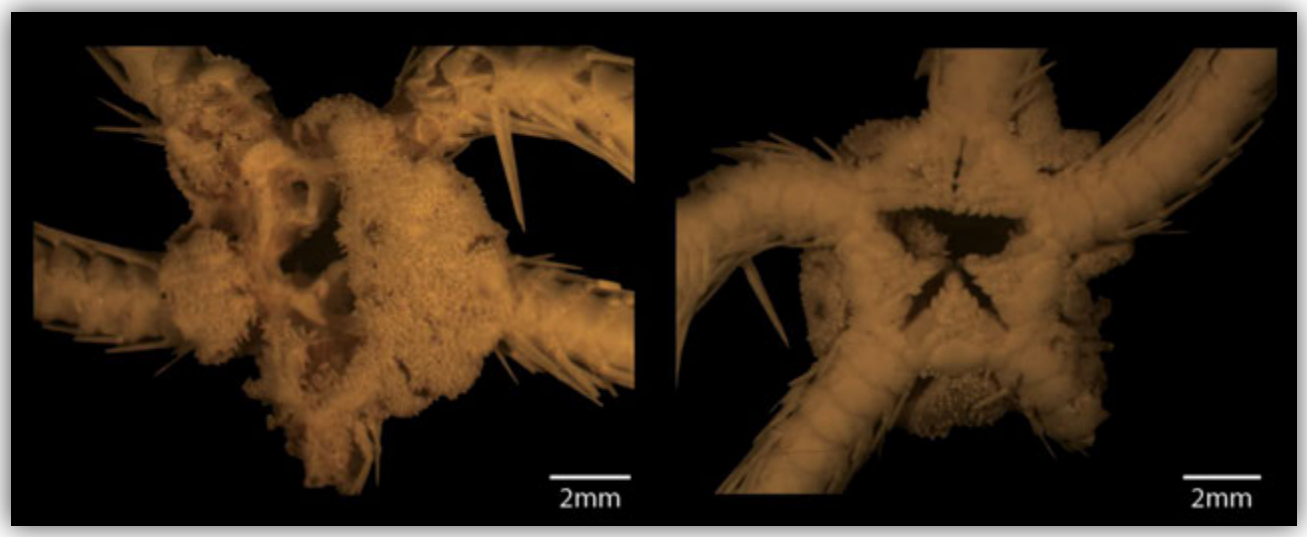

Figure 6.217. Dorsal (left) and ventral (right) views of *Ophiolimna perfida* (SAMC A22936).

Genus Ophiomitrella Verrill, 1899

Diagnosis - *adapted from Verrill (1899b) and Clark and Courtman-Stock (1976).*
Disc not constricted interradially, disc armament covered in large, thick scales and bearing stumps or granules of varying densities. Radial shields broad, rounded, may be widely separated or partially contiguous. Oral shields usually wider than long. Adoral shields relatively large, wide and contiguous. Oral papillae three, papilliform either side of infradental papillae. Dorsal arm plates small rhombic or fan-shaped, not contiguous. Ventral arm plates fan- or bell-shaped, not contiguous. Arm spines long and slender. Tentacle pores small. Tentacle scales small, single.

Ophiomitrella corynephora H.L. Clark, 1923

Figs 6.218 and 6.219.

Ophiomitrella corynephora Clark, 1923: 322-324, fig. 2, pl. 19, figs 5, 6; Mortensen, 1933c: 331-333, figs 48, 49; Clark, A.M., 1952: 199, 212; Clark, 1974: 441; Clark and Courtman-Stock, 1976: 105, 121, 169, figs 172, 177; Alva and Vadon, 1989: 829.

Diagnosis *- adapted from Clark (1923).*

D.D. up to 10mm, D.D./ A.L. = 1/3-4. Disc round, covered with overlapping scales bearing cylindrical granules with rounded tips. Some scales with multiple granules, others bare. Radial shields about one-third to half disc radius, naked or covered in similar granules to dorsal disc, rounded triangular, as wide as long, separated from each other by a series of scales. Ventral interradial areas covered in same granules as dorsal disc, but scattered and less dense. Oral shields diamond-shaped, wider than long, two proximal sides slightly concave, distal sides convex. Adoral shields large, contiguous. Jaws sunken. Oral papillae three, large, tapering, thick. Teeth four, squarish to pointed. A calcified elevation distal to outermost oral papillae arising from edge of first ventral arm plate adjoining oral tentacle pore. Genital slits long and narrow. Dorsal arm plates rhombic, not contiguous. Ventral arm plates rhombic with very rounded, obtuse distal edge, almost half moon-shaped, basal ventral arm plates with rounded distal edge. Arm spines up to seven, smooth or very finely serrated, uppermost long, pointed, exceeding one segment length, lowermost two spines short and blunt. Tentacle scale single, moderately large, narrow, long and tapering, but blunt. Colour in life white to red and pink.

Distribution and habitat

South Africa: Orange River (NC) to off Clansthal (KZN); depth range: 42-900m.
Habitat: Rock, sand, mud, stones and on alcyonarians.

Remarks

Endemic to South Africa (see Table 7.4). Clark (1923) states that SAMC A6441 (examined) is the holotype, but the specimen label reads that it is a paratype. The holotype was not found. Distribution within South Africa here extended north to Clansthal in KZN and west from Port Elizabeth to Orange River in the Northern Cape (see Table 7.3). The type locality is Vasco da Gama Peak, Cape, depth 42m.

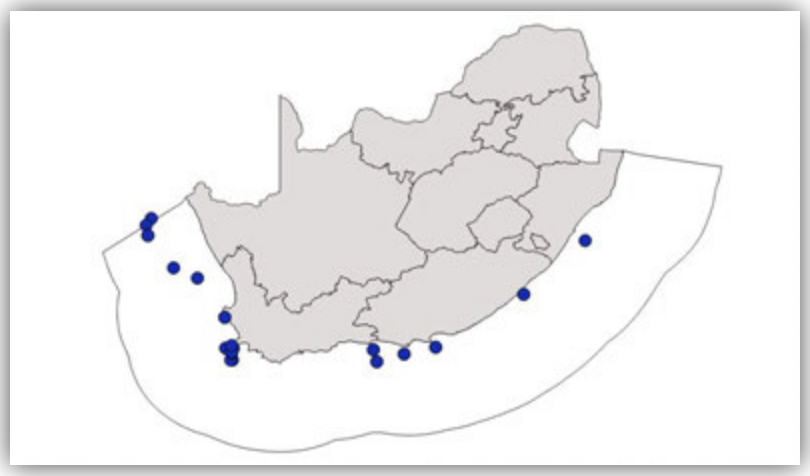

Figure 6.218. Distribution of *Ophiomitrella corynephora* in South Africa.

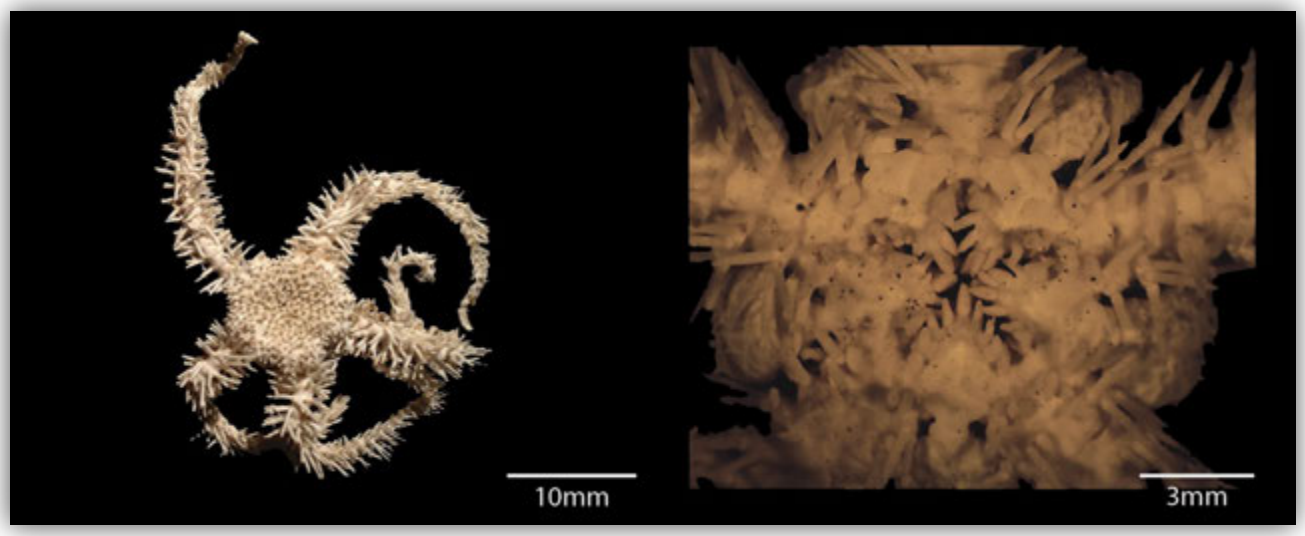

Figure 6.219. Dorsal (left) and ventral (right) views of *Ophiomitrella corynephora* (SAMC A23252).

***Ophiomitrella hamata* Mortensen, 1933**

Figs 6.220 and 6.221.

Ophiomitrella hamata Mortensen, 1933c: 333-335, figs 50, 51, pl. 19, fig. 12; Clark and Courtman-Stock, 1976: 105, 121, 169, figs 168, 178; Olbers *et al.*, 2014: 16, pl. 3C.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 4mm, D.D./A.L. = 1/3. Disc round, covered with scales bearing short rugose-tipped stumps, some scales with multiple stumps, while others have one. Radial shields no more than one-third disc radius, converging, contiguous distally only, oval in shape, longer than wide. Ventral interradial areas covered in same stumps. Oral shields diamond-shaped, wider than long, with two proximal sides slightly concave. Adoral shields large, contiguous. Jaws not sunken. Oral papillae three, large, similar in size and shape. Teeth four. Genital slits long and narrow. Dorsal arm plates rhombic, not contiguous. Ventral arm plates rhombic with very rounded obtuse distal edge, becoming almost flat in mid-arm, first ventral arm plates fan-shaped with rounded distal edge, first two ventral arm plates narrowly contiguous. Arm spines up to five, serrated, longest not exceeding segment length. Tentacle scales single, small, pointed.

Distribution and habitat
South Africa: Waterfall Bluff (EC) to Durban (KZN); depth range: 63-900m.
Habitat: On gorgonians, including *Thouarella* species.

Remarks
Endemic to South Africa (see Table 7.4). The distribution is here extended to the Eastern Cape. Type material was located in Iziko South African Museum (syntype: SAMC A22380; examined), type locality is off Durban, KZN, depth 412m.

Figure 6.220. Distribution of *Ophiomitrella hamata* in South Africa.

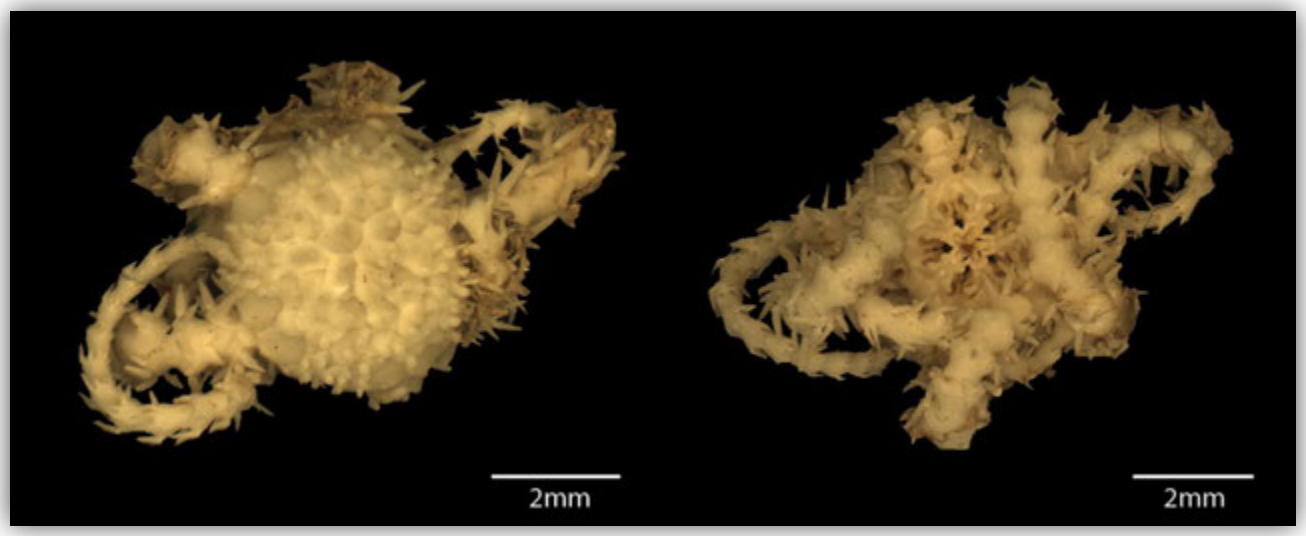

Figure 6.221. Dorsal (left) and ventral (right) views of *Ophiomitrella hamata* (DNSM ECH26).

Genus *Ophiophthalmus*[9] Matsumoto, 1917

Diagnosis *- adapted from Matsumoto (1917), Koehler (1922b) and Paterson (1985).*
Disc covered with irregular scales, may be armed with coarse granules. Radial shields naked, round or oval. Oral papillae 3-6. Teeth present in single series. Dorsal arm plates contiguous only in basal segments. Arm spines numerous, long, conical, finely serrated, do not approximate dorsally. Tentacle scale single, large, flat, elliptical leaf-shaped.

To distinguish *Ophiophthalmus* from *Ophiomitrella*, Matsumoto (1917) suggested that in *Ophiopthalmus*, the basal dorsal arm plates are contiguous and there is an absence of a fan arrangement of arm spines on the basal arm segments. Subsequently, Koehler (1922b) also distinguished that the disc scales were imbricating and radial shields were naked and round. However, Paterson (1985) suggested that these characters are not reliable or consistent across all species within the genera and that a comprehensive revision of both *Ophiophthalmus* and *Ophiomitrella* is required.

[9] Paterson (1985) correctly stated that *Ophiophthalmus* is a junior homonym of the reptilian genus described by Fitzinger, 1843. A replacement is required.

***Ophiophthalmus relictus* (Koehler, 1904)**

Figs 6.222 and 6.223.

Ophiacantha relicta Koehler, 1904a: 106-107, pl. 17, figs 4-6.
Ophiacantha oedidisca Clark, 1911: 219-221, fig. 101.
Ophiophthalmus relictus: Koehler, 1922b: 124-127, pl. 9, figs 1-4, pl. 95, fig. 3; Clark, A.H., 1939: 54-55; Clark, 1977: 130, 140; Baker, 1979: 39; Rowe and Gates, 1995: 375; O'Hara and Stöhr, 2006: 134.

Diagnosis *- adapted from Koehler (1904a), Clark (1911) and Koehler (1922b).*
D.D. up to 12mm, D.D./A.L. = 1/5. Disc round, tumid or swollen, covered in closely-packed minute granules, but not touching each other, granules may have thorns. Radial shields well-separated, naked, oval, longer than wide. Ventral interradial areas covered in same granules, but not as dense. Oral shields diamond-shaped, wider than long, with two proximal sides slightly concave. Adoral shields narrow, long, straight, contiguous. Oral papillae 3-4, long, flat, pointed. Genital slits long. Dorsal arm plates triangular, may be contiguous basally, wider than long, distal margin of basal plates may have granules like those on disc. First ventral arm plates small, wider than long, but narrow distally, plates becoming squarish, their outlines becoming indistinct, not contiguous. Lateral arm plates fairly small, not meeting dorsally or ventrally. Arms flexible dorsoventrally. Arm spines up to six, usually five, thorny, stout, short, upper two longest, longer than one segment in length, lowest arm spine with rough tips, arm spines do not reach to mid-dorsal arm. Tentacle scale single, small, pointed.

Distribution and habitat
Western Indian Ocean, Gulf of Aden, Japan, Indonesia, and northern Tasman Sea (Baker 1979; Rowe and Gates, 1995), South Africa: Richards Bay (KZN) to Black Rock (KZN); depth range: 100-2194m. Habitat: Mud, fine grey sand, foraminifera, small stones, epizoic.

Remarks
Type material is in the Zoological Museum Amsterdam (now Naturalis) (ZMA.ECH.O.2351-ZMA.ECH.O.2359) and the type locality is the Indo-Malayan Region (Rowe and Gates, 1995); depth unknown.

Figure 6.222. Distribution of *Ophiophthalmus relictus* in South Africa.

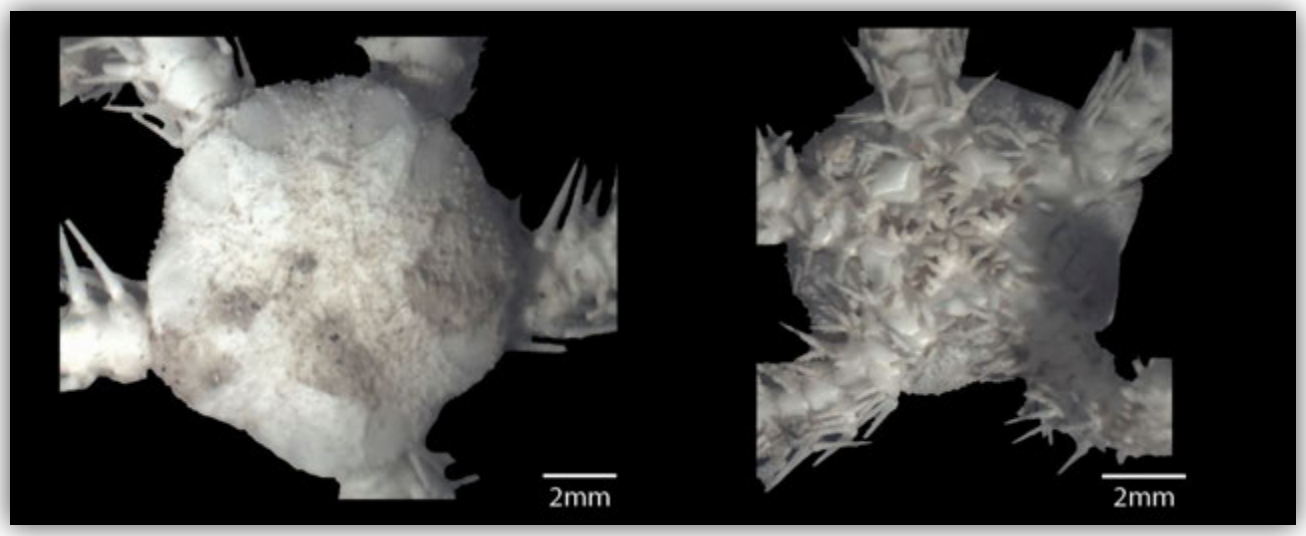

Figure 6.223. Dorsal (left) and ventral (right) views of *Ophiophthalmus relictus* (SAMC A22929).

Genus Ophioplinthaca Verrill, 1899

Diagnosis - *adapted from Verrill (1899a).*
Interradial areas deeply constricted, centre of disc deeply concave, disc scales large, no armament on ventral interradial areas. Disc marginal and submarginal scales large and specialised. Radial shields large, naked. Oral shields contiguous with first lateral arm plates. Arm spines long, thorny, not approximating dorsally. First tentacle pore large, with one or two tentacle scales.

Ophioplinthaca papillosa H.L. Clark, 1939

Figs 6.224 and 6.225.

Ophioplinthaca papillosa Clark, H.L., 1939: 49-51, figs 10, 11; Clark, 1977: 135, 140-141.

Diagnosis - *adapted from Clark, H.L. (1939).*
D.D. up to 10mm, A.L. 50-60mm, D.D./A.L. = 1/5. Disc tumid, but deeply concave in centre and constricted in interradial areas. Disc covered with irregular scales. Centre of disc with distinct thorny stumps terminating in 2-6 sharp teeth. Margin and interradial areas may have scattered stumps including in creases. Radial shields large, narrow, naked, length just more than half disc radius. Ventral interradial areas small and covered in disc scales with no stumps. Genital slits wide and moderately long, but do not reach disc margin. Oral shields diamond-shaped, wider than long. Adoral shields fairly wide, contiguous. Oral papillae 3-4, subequal, narrow, long, pointed. Arms five. Dorsal arm plates broadly bell-shaped, distal margin convex, not contiguous. Ventral arm plates small, wider than long, proximal margin almost straight, proximal edge slightly concave, not contiguous. Lateral arm plates large, meeting dorsally and ventrally. Arm spines up to seven, not approximating dorsally, uppermost two longest, usually equal to three segments, but in one specimen (SAMC A22918) uppermost spine on second segment six times segment length, lowermost spine shortest and also exceeds one segment length, tapering, finely serrated. Tentacle scale single, moderately large, flat, pointed.

Distribution and habitat
Gulf of Aden and Maldive area (Clark 1939), South Africa: off Richards Bay (KZN); depth range: 1000-1200m.

Habitat: No information available.

Remarks
A single damaged specimen from North of Nhlabane (KZN) from 1000-1200m was available for examination.

The type material is in the Museum of Comparative Zoology (paratype: MCZ OPH-6009), type locality Maldives, depth 914-1646m.

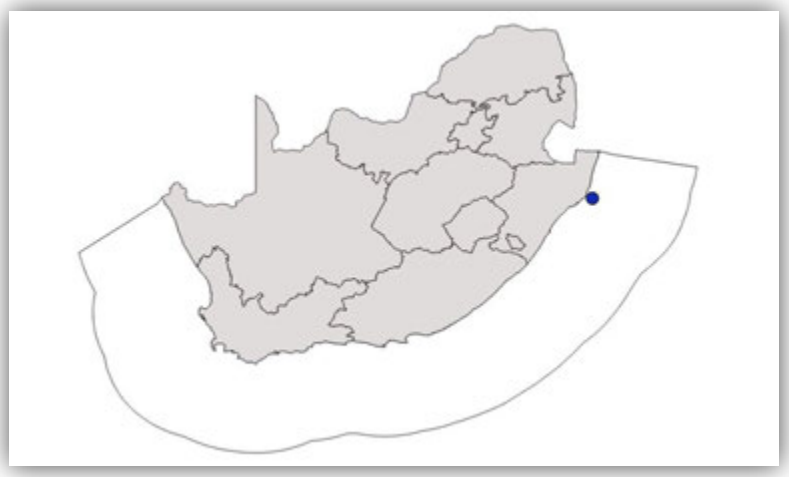

Figure 6.224. Distribution of *Ophioplinthaca papillosa* in South Africa.

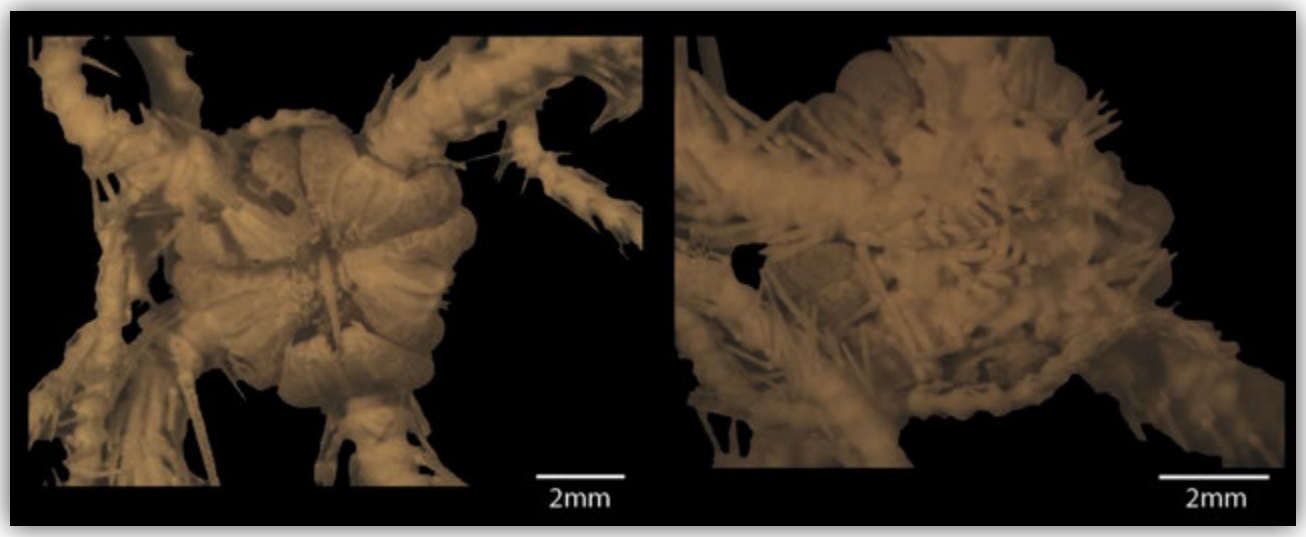

Figure 6.225. Dorsal (left) and ventral (right) views of *Ophioplinthaca papillosa* (SAMC A22918).

***Ophioplinthaca rudis* (Koehler, 1897)**
Figs 6.226 and 6.227.

Ophiomitra rudis Koehler, 1897: 358-360; Koehler, 1899: 65; pl. 7, figs 58, 59.
Ophioplinthaca rudis: Koehler, 1904a: 132; Clark, 1915a: 211; Koehler, 1922b: 142-147, pl. 24, figs 1-6, pl. 96, fig. 1; Clark, 1915a: 46-47; Clark, 1977: 135, 141; Imaoka *et al.*, 1990: 17, 79; Rowe and Gates, 1995: 375; O'Hara and Stöhr, 2006: 85-86, fig. 9A-C.
Ophiomitra cardiomorpha Clark, 1911: 179-180, fig. 81.

Diagnosis *- adapted from Koehler (1922b) and Clark (1977).*
D.D. up to 16mm. A.L. 90mm, D.D./A.L. = 1/5-6. Disc tumid, but not deeply concave in centre, interradial areas constricted. Disc covered with irregular scales and spines. Disc centre with distinct long spines, disc margin spines conical, present adjacent to radial shields but absent or sparse elsewhere. Radial shields large, triangular, twice as long as wide, slightly more than half disc radius, separated for entire length, but approximating distally. Ventral interradial areas heart-shaped, covered in smooth scales. Oral shields diamond-shaped, as long as wide or slightly wider, with distal lobe. Adoral shields large, contiguous. Oral papillae 5-6, all pointed except proximal- and second proximal-most, which are flattened. Apical papillae larger than other oral papillae. Genital slits distinct. Dorsal arm plates fan-shaped, twice as wide as long, distal margin slightly convex or straight, contiguous basally. Ventral arm plates triangular, wider than long, distal edge straight, longer than proximal edge, lateral margins concave, diverging distally, only first two basal plates contiguous. Lateral arm plates large, meeting dorsally and ventrally relatively narrowly. Arms five, wide compared to other ophiacanthids. Arm spines up to seven, slender, long, uppermost 3-4 segments in length, sharp, lowermost being blunt, shortest and more serrated than others, spines do not approximate to dorsal midline. Tentacle scale single, moderately large, thick, sharply pointed. Colour in life red (Imaoka *et al.*, 1990).

Distribution and habitat
Indo-West Pacific (Clark, 1977; Imaoka *et al.*, 1990; Rowe and Gates, 1995), South Africa: Richards Bay (KZN) to Black Rock (KZN); depth range: 165-3124m.
Habitat: Mud and sand.

Remarks
Koehler (1897) included incorrect figures in the original description (plate 9; figures 75 and 76) which caused some confusion and led to Clark (1911) describing the species as new, *Ophiomitra cardiomorpha.* Later, Clark, H.L. (1939) noted this error and included photographs of *Ophioplinthaca rudis*.

O'Hara and Stöhr (2006) designated a lectotype (ZSI 8581/6), type locality Bay of Bengal, depth 1450m and suggested that the “form of the long slender spines is very characteristic of this species”.

Figure 6.226. Distribution of *Ophioplinthaca rudis* in South Africa.

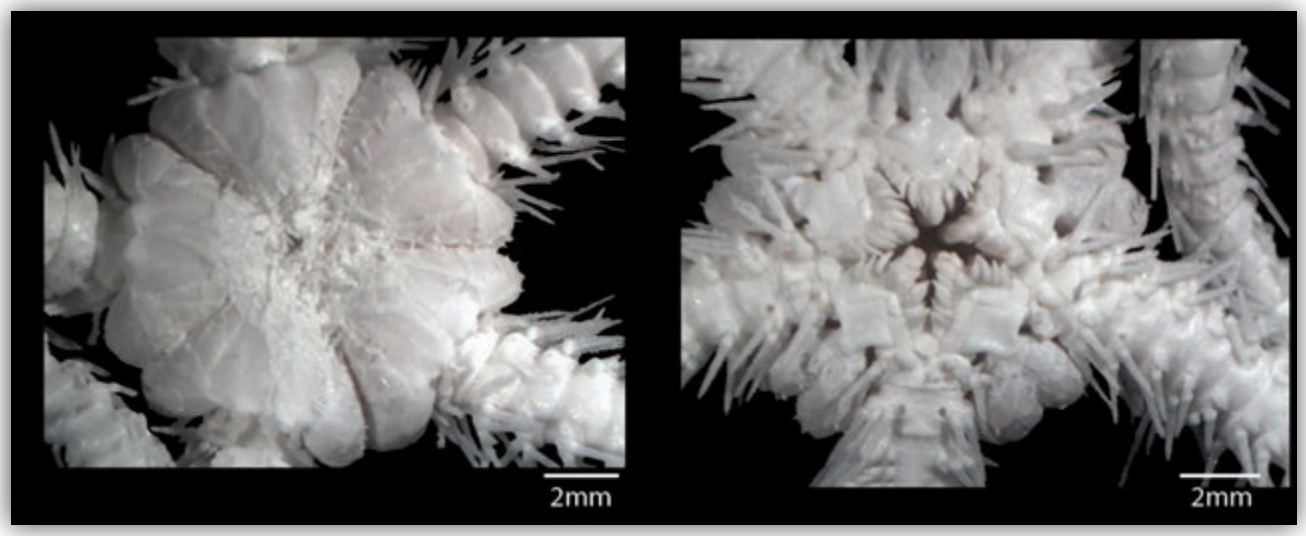

Figure 6.227. Dorsal (left) and ventral (right) views of *Ophioplinthaca rudis* (SAMC A22913).

Ophioplinthaca sexradia **Mortensen, 1933**

Figs 6.228 and 6.229.

Ophioplinthaca sexradia Mortensen, 1933c: 326-327, fig. 45; Clark and Courtman-Stock, 1976: 105, 121, 170.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 2.5mm. A.L. = 12mm. D.D./A.L. = 1/ 4-5. Disc tumid, slightly concave in centre and interradial areas constricted. Disc covered with irregular scales, granules and stumps, mainly towards centre of disc. Dorsal interradial areas almost not present due to large radial shields. Radial shields large, triangular, approximating, contiguous distally, more than half disc radius in length. Ventral interradial areas almost not-existent as deeply constricted. Oral shields rhombic with obtuse distal edge, slightly wider than long. Adoral shields large, contiguous, wider distally. Oral papillae three, distalmost broader. Genital slits short. Dorsal arm plates triangular, not contiguous, distal edge slightly convex. Ventral arm plates pentagonal, wider than long, distal edge convex. Lateral arm plates meeting dorsally and ventrally. Arms six. Arm spines up to four, thick, short, tapering, shorter than single segment. Tentacle scale small, single, pointed.

Distribution and habitat
South Africa: East London (EC); depth range: 44m.
Habitat: On gorgonians.

Remarks
Endemic to South Africa (see Table 7.4). No material is housed in the Iziko South African Museum collection. Type material in the Natural History Museum of Denmark (syntype: ZMUC OPH-278) and the type locality is near East London, depth 44m.

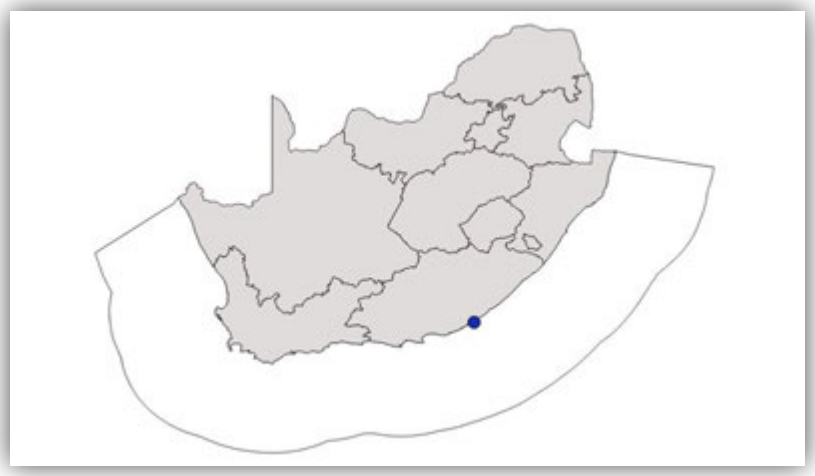

Figure 6.228. Distribution of *Ophioplinthaca sexradia* in South Africa.

Figure 6.229. Dorsal (left) and ventral (right) views of *Ophioplinthaca sexradia* (ZMUC OPH-278).

Genus Ophiothamnus Lyman, 1869

Diagnosis - *adapted from Lyman (1869) and Lyman (1882).*
Disc tumid and overlying arm bases covered with large scales, scattered with fine thorns or spines. Radial shields naked, large, wide and contiguous for most of their length. Adoral shields long and stout, contiguous, extending outside oral shields, creating a raised pentagon. Teeth present. Oral papillae stout, closely packed. Lateral arm plates meeting dorsally and ventrally. Arm spines numerous (up to eight), serrated, may meet on dorsal midline. Genital slits begin close to oral shields.

Ophiothamnus remotus Lyman, 1878

Figs 6.230 and 6.231.

Ophiothamnus remotus Lyman, 1878: 149-150, pl. 8, figs 201-203, Studer, 1882: 24; Lyman, 1882: 212-213, pl. 14, figs 1-3; Bell, 1905: 258; Clark, 1923: 324-325; Mortensen, 1933c: 327-330, figs 46, 47a; Clark and Courtman-Stock, 1976: 105, 121, 170-171, fig. 171.
Ophiothamnus remotus var. *cordatus* Mortensen, 1933c: 330-331, fig. 47b. Clark, 1977: 135.

Diagnosis *- adapted from Lyman (1878) and Mortensen (1933c).*
D.D. up to 3.5mm. A.L. = 12mm, D.D./A.L. = 1/3-4. Disc tumid, dorsally covered with scales and scattered, tapering spines. Radial shields large, triangular, inner sides convex, more than half disc radius, contiguous for more than half their length. Ventral interradial areas almost not existent as deeply constricted. Oral shields small, triangular or heart-shaped, distal side may be slightly convex or concave. Adoral shields large, broadly contiguous. Oral papillae three, distalmost broad and opercular. Genital slits short. Dorsal arm plates triangular, with rounded corners, wider than long, not contiguous. Ventral arm plates pentagonal, not contiguous. Lateral arm plates meeting dorsally and ventrally. Arm spines seven, slender, smooth or finely serrated, pointed, only two uppermost spines exceeding segment length. Tentacle pores small. Tentacle scales small, single, pointed. Colour in life orange.

Distribution and habitat
South Africa: Jakkelshoek (NC) to Black Rock (KZN); depth range: 88-900m.
Habitat: Rock, sand, stones, mud and gravel.

Remarks
Endemic to South Africa (see Table 7.4). Studer (1882) erroneously recorded this species at 34º13'S; 18º0'W (mid Atlantic Ocean) but Mortensen (1933c) believed this was an error and it should have read 34º13'S; 18º00'E, which places it off the Cape of Good Hope. The type material is in the Natural History Museum of Denmark (syntype: ZMUC OPH-76) and the type locality is Agulhas Bank, depth 275m.

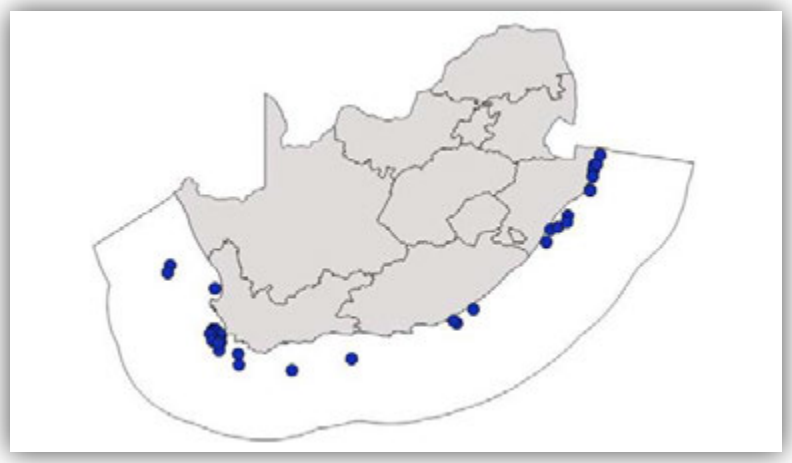

Figure 6.230. Distribution of *Ophiothamnus remotus* in South Africa.

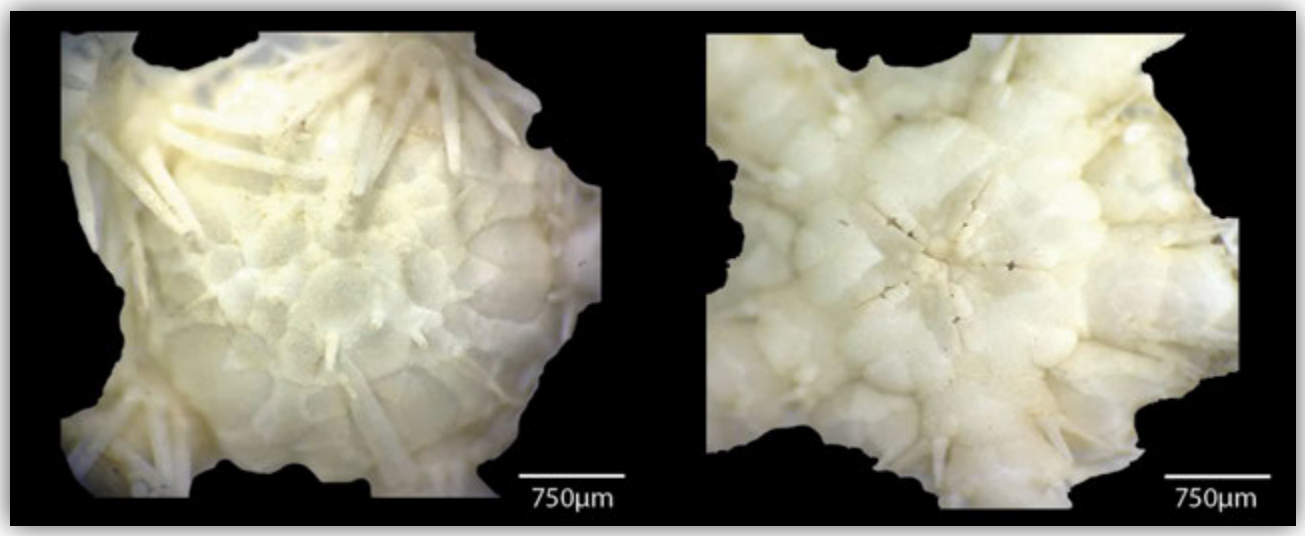

Figure 6.231. Dorsal (left) and ventral (right) views of *Ophiothamnus remotus* (SAMC A073875).

Genus Ophiotoma Lyman, 1883

Diagnosis *- adapted from Martynov (2010) and Lyman (1883).*
Disc with numerous small scales and sometimes spinelets of various lengths. Radial shields elongated, distinct. Oral papillae short, conical. Oral tentacle scales in continuous series with oral papillae. Teeth broad, conical to rectangular. Oral shields broadly spearhead-shaped, with a short distal lobe. Adoral shields with distal wings, proximally tapered. Dorsal and ventral arm plates well-developed. Arm spines relatively long, rounded, smooth, not hooked. Tentacle pores relatively large. Tentacle scales small, rudimentary or absent.

Ophiotoma cf. *alberti* (Koehler, 1896)
Figs 6.232 and 6.233.

Ophiotrema alberti Koehler, 1896a: 251; Koehler, 1906: 6; Koehler, 1907: 324; Koehler, 1908a: 612; Koehler, 1909b: 196-198; Matsumoto, 1915: 62; Koehler, 1922b: 90; Mortensen, 1927: 183; Gage *et al.*, 1983: 288; Paterson, 1985: 57-58, fig. 3; Smirnov *et al.*, 2014: 197.
Ophiotoma alberti: Madsen, 1951: 113; O'Hara and Stöhr, 2006: 75; Martynov, 2010: 18, 92, 97-103, 126, 131, figs 66A-E, 67A, 68, 6C, H, 13C, E, F, 18L, 28B; Olbers *et al.*, 2015: 104, pl. 6C, D.

Diagnosis *- adapted from Paterson (1985) and Martynov (2010).*
D.D. up to 17mm. Disc with small scales, scattered spinelets also extending onto ventral interradial areas. Radial shields naked, sometimes visible, rounded pear-shaped. Oral papillae 4-5, in continuous series with two scales in oral tentacle pores. Oral shields large, wider than long, nearly D-shaped, with rounded proximal edge and slight distal lobe. Adoral shields wing-like, proximal edge indented opposite second oral tentacle pore. Dorsal arm plates triangular to bell-shaped, twice as wide as long, nearly contiguous. Ventral arm plates rectangular, with obtuse proximal angle and slight indent on distal edge, nearly contiguous on proximal arm. Arm spines four, glassy, smooth, slightly flattened, rounded tip, uppermost longest, up to two segments in length. Tentacle pores large. Tentacle scales needle-like or round, variable, small if not absent, 0-5 in number.

Distribution and habitat
North Eastern Atlantic (Paterson, 1985), South Africa: off Cape Town (WC); depth range: 1862-4354m.
Habitat: No information available.

Remarks
Olbers *et al.* (2015) recorded this species as a new record for South Africa.

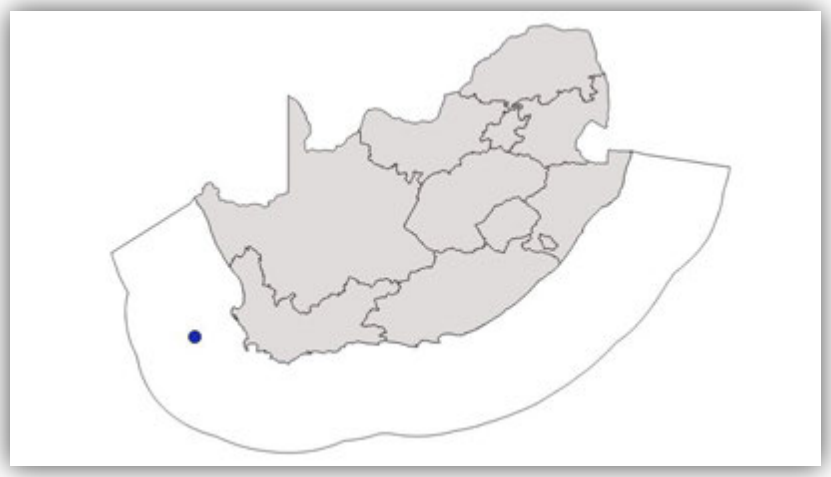

Figure 6.232. Distribution of *Ophiotoma* cf. *alberti* in South Africa.

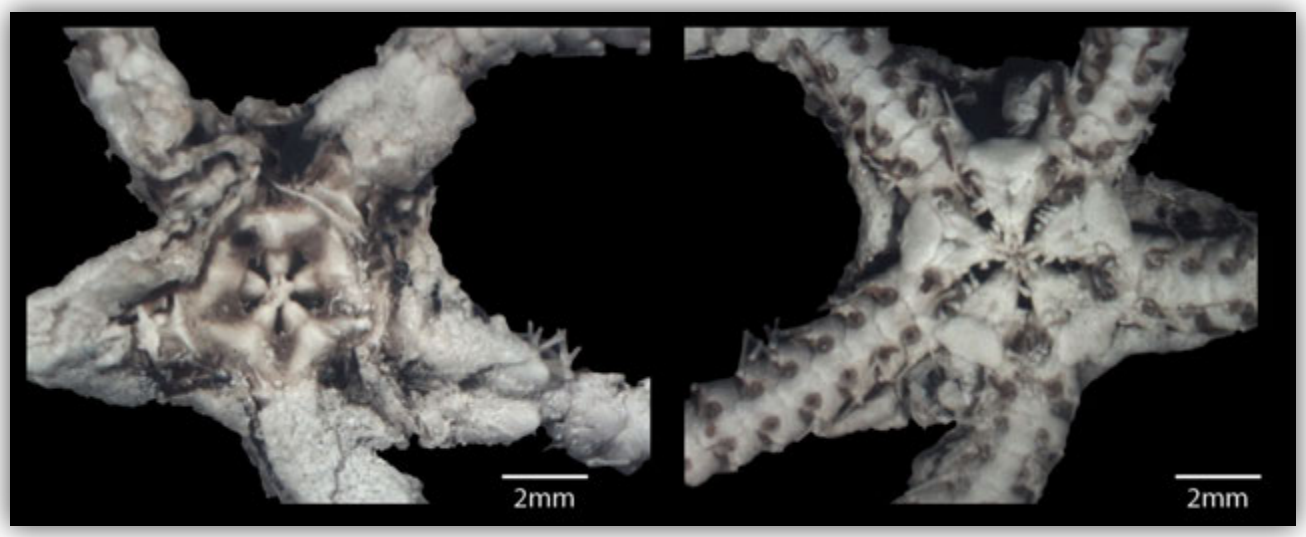

Figure 6.233. Dorsal (left) and ventral (right) views of *Ophiotoma* cf. *alberti* (SAMC A22112).

***Ophiotoma* cf. *gracilis* (Koehler, 1914)**

Figs 6.234 and 6.235.

Ophiotrema gracilis Koehler, 1914a: 112-114, pl. 12, figs 1, 2; Paterson, 1985: 54, 58, fig. 23; Borrero-Perez *et al.*, 2008: 181, fig. 7I.
Ophiotoma gracilis: Martynov, 2010: 98, 103, 141; Olbers *et al.*, 2015: 104-105, pl. 6E, F.

Diagnosis *- adapted from Paterson (1985) and Martynov (2010).*
D.D. up to 11mm. Disc with small scales, scattered spinelets also extending onto ventral interradial areas, but not up to oral shields. Radial shields naked, elongated triangular, rounded distal margin, separated but diverging. Oral papillae five, conical, in a continuous series with two scales in oral tentacle pores, which are more elongated, almost spiniform. Oral shields large, much wider than long, spearhead-shaped, with distinct distal lobe. Adoral shields elongated, contiguous. Genital slits narrow. Dorsal arm plates triangular, distal edge convex, almost as long as wide, not contiguous. Ventral arm plates pentagonal, proximal edge concave and obtuse, lateral edges excavated by tentacle pores, much longer than wide, not contiguous. Arms relatively slender. Arm spines four, fine, smooth, pointed, uppermost longest, up to one-and-a-half segments in length. Tentacle pores large. Tentacle scales subequal, 5-6, spinose.

Distribution and habitat
Lesser Antilles and Columbia (Borrero-Pérez *et al.* 2008), South Africa: off Cape Town (WC); depth range: 490-2948m.
Habitat: No information available.

Remarks
Olbers *et al.* (2015) recorded this species as a new record for South Africa. In addition, they noted a number of differences which occur between *Ophiotoma alberti* and *O. gracilis.* In *O*. *gracilis* the arms are more slender, arm spines finer, dorsal arm plates narrower, smaller and more widely separated, ventral arm plates longer, the oral tentacle pore scales are different in size and shape to the oral papillae and the oral shields are spearhead-shaped. The tentacle scales in *O. alberti* are small, while in *O. gracilis* they are spinose and more distinct.

According to Borrero-Perez *et al.* (2008) the type locality is Lesser Antilles and the type is in the Smithsonian Institution (USNM 32301), depth 1256m (Koehler, 1914a).

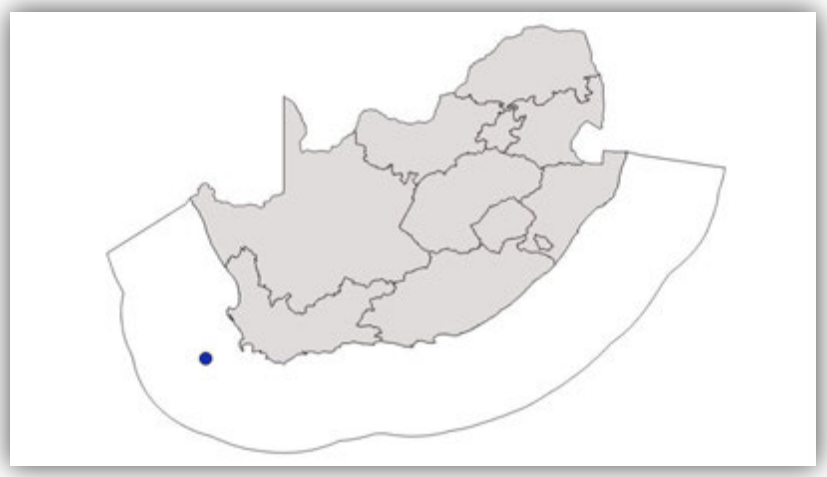

Figure 6.234. Distribution of *Ophiotoma* cf*. gracilis* in South Africa.

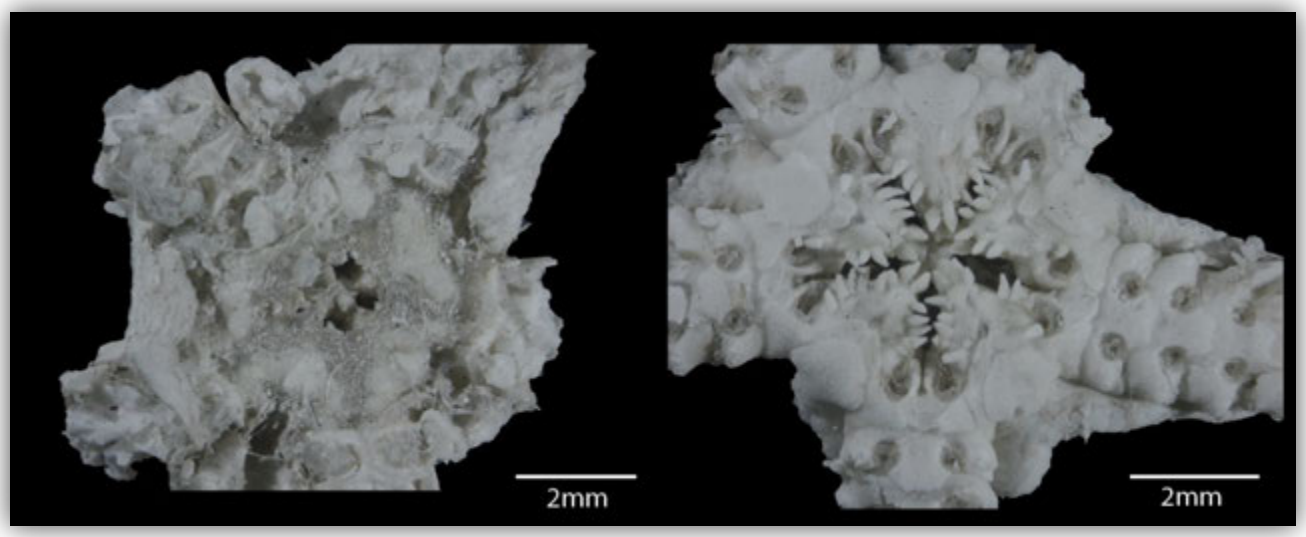

Figure 6.235. Dorsal (left) and ventral (right) views of *Ophiotoma* cf*. gracilis* (SAMC A22103).

Genus Ophiotreta Verrill, 1899

Diagnosis *- adapted from Verrill (1899b).*
Oral papillae 3-5. Adoral shields may or may not be contiguous. Ventral arm plates as wide as long, proximal edge obtuse, distal edge convex, not contiguous distally. Arm spines cylindrical, but tapering slightly, flattened, slender, serrated or nearly smooth, do not approximate towards dorsal midline. Tentacle scales large, two, becoming smaller distally with only a single scale on distal arm.

Koehler (1922b) and Clark and Courtman-Stock (1976) noted that *Ophiotreta* is more similar to Ophiocomidae and Ophiodermatidae and does not strictly conform to the Ophiacanthidae. The arrangement of the oral papillae, presence of an oral tentacle scale, disc granulation and contiguous dorsal arm plates are quite different. For the purposes of this study, *Ophiotreta* is regarded as a member of the family Ophiacanthidae.

Ophiotreta durbanensis (Mortensen, 1933)

Figs 6.236 and 6.237.

Ophiacantha (*Ophiotreta*) *durbanensis* Mortensen, 1933c: 324-325, fig. 44, pl. 19. figs 13-15. *Ophiacantha durbanensis*: Clark and Courtman-Stock, 1976: 105, 121, 171, fig. 176.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 7mm, A.L. = 40mm, D.D./A.L. = 1/6. Disc not constricted interradially. Disc covered with fine granules scattered, sometimes with few spines interspersed, extending to ventral interradial areas, leaving areas closest to genital slits naked. Radial shields small, oval, partly naked, widely separated. Oral shields spearhead-shaped, longer than wide, distal sides slightly sunken. Adoral shields approximating or just contiguous. Oral papillae 5-6, oral tentacle scale also present at distal end of series. Genital slits narrow. Dorsal arm plates fan-shaped or triangular, distal edge slightly convex, just contiguous. Ventral arm plates broad fan-shaped, slightly wider than long, distal edge convex, contiguous, at least basally. Arm spines up to five, tapering, smooth or finely serrated, two segments in length, middle spines may be truncated. Tentacle pores small. Tentacle scales two, becoming one on distal arms, small, papilliform. Colour faint mottling of white and brown which disappears on distal arms.

Distribution and habitat
South Africa: Durban (KZN) to Sodwana Bay (KZN); depth range: 400-550m.
Habitat: No information available.

Remarks
Endemic to South Africa (see Table 7.4). The syntype is in the Natural History Museum of Denmark (ZMUC OPH-116) and the type locality is Durban, depth 411m.

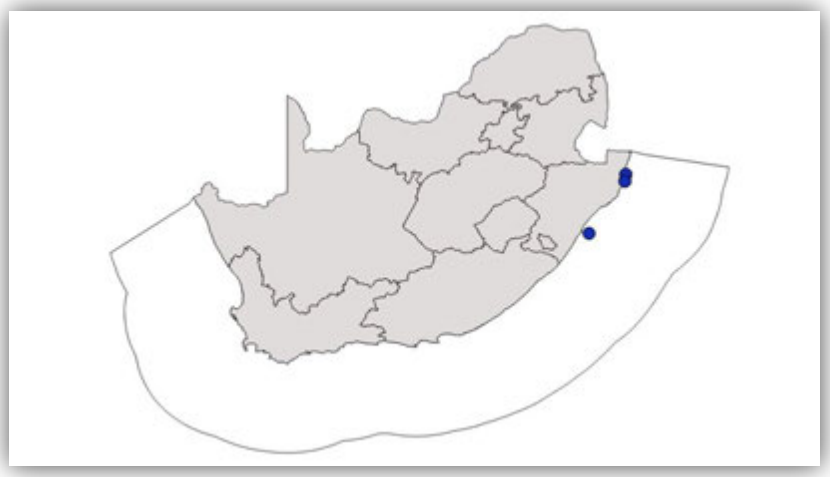

Figure 6.236. Distribution of *Ophiacantha* (*Ophiotreta*) *durbanensis* in South Africa.

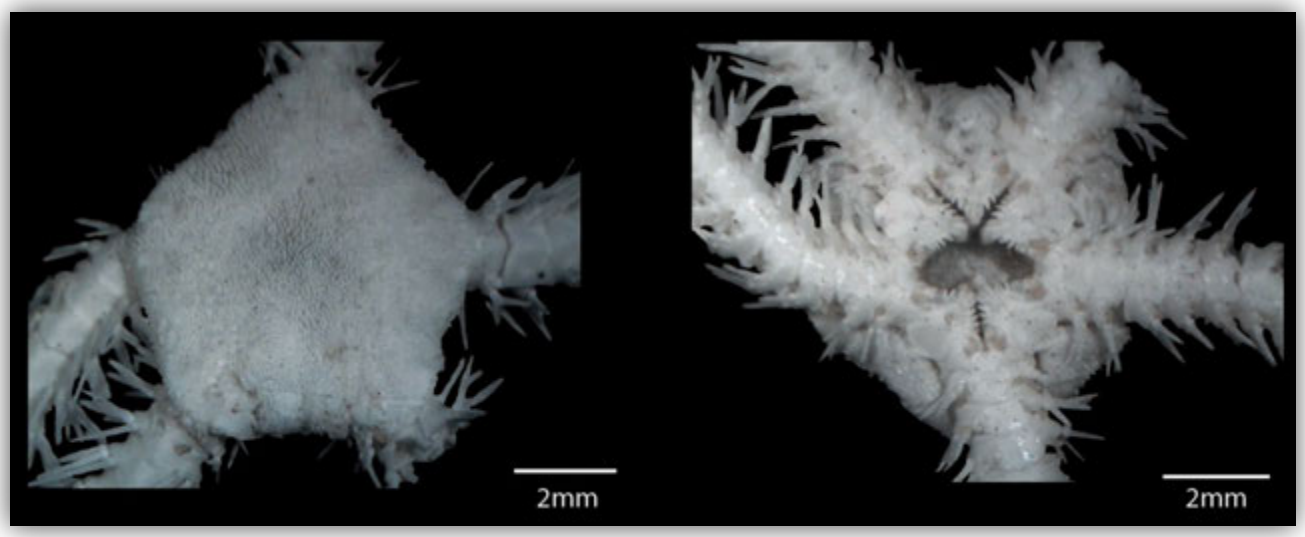

Figure 6.237. Dorsal (left) and ventral (right) views of *Ophiacantha* (*Ophiotreta*) *durbanensis* (SAMC A22797).

Ophiotreta matura **(Koehler, 1904)**

Figs 6.238 and 6.239.

Ophiacantha matura Koehler, 1904a: 112-113, pl. 23, figs 2-4.
Ophiotreta matura Koehler, 1922b: 76-81, pl. 12, figs 1-6, pl. 13, figs 1-5, pl. 14, figs 1-5, pl. 15, figs 1-3, pl. 95, fig. 2; Koehler, 1930: 66; Clark, H.L., 1939: 53-54; Clark, 1977: 135, 141; Clark and Courtman-Stock, 1976: 121 (footnote); O'Hara and Stöhr, 2006: 59-60, figs 4h-l, 17r.
Ophioprium kapalae: Baker, 1979: 38-39, fig. 6g-m.
Ophiotreta kapalae: Paterson, 1985: 56.

Diagnosis *- adapted from O'Hara and Stöhr (2006).*

D.D. up to 8mm, D.D./A.L. = 1/4. Disc not constricted interradially. Disc covered in dense spines obscuring underlying plates, disc spines long, thorny, several with multiple thorns at tips, extending to ventral interradial areas, leaving areas closest to genital slits naked. Radial shields covered in disc armament. Oral shields diamond-shaped, wider than long, distal edge convex. Adoral shields short, thick, contiguous. Oral papillae up to seven, with one or two oral tentacle scales at distal end of series, all spiniform. Genital slits wide. Dorsal arm plates triangular, distal edge convex, not contiguous, basal

plates with tiny spines. Ventral arm plates fan-shaped, equally wide as long, distal edge strongly convex, not contiguous. Arm spines up to eight, finely serrated, tapering, uppermost longest, up to five segments long, lowest spine hooked on distal segments, spines meeting at dorsal midline. Tentacle scales two on basal pores, large, wide and rounded, becoming tapered sharp and thorny tipped, may be longer than ventral arm plate. Colour slightly green when dry (O'Hara and Stöhr, 2006).

Distribution and habitat

Gulf of Aden, Indonesia, Philippines, eastern Australia, New Caledonia (O'Hara and Stöhr, 2006), South Africa: North of Richards Bay (KZN) to Sodwana Bay (KZN); depth range: 239-1270m.
Habitat: No information available.

Remarks

Clark and Courtman-Stock (1976) only mentions *Ophiotreta matura* in a footnote, noting that *O. matura* differs from *O. durbanensis* by the dense covering of elongated spinelets on disc and single, very large tentacle scale. Clark (1977) recorded this species as a new record for southern Africa. The type material is in the Zoological Museum Amsterdam (now Naturalis) (syntype: ZMA.ECH.O.2349) and the type locality is Maluku, Indonesia, depth 397m.

Figure 6.238. Distribution of *Ophiotreta matura* in South Africa.

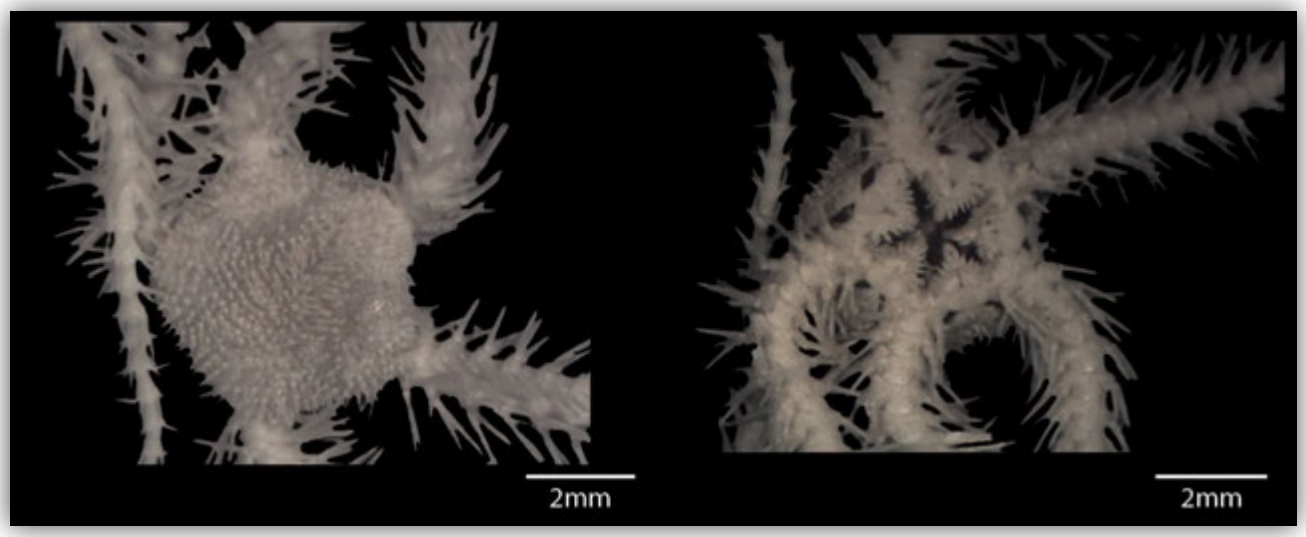

Figure 6.239. Dorsal (left) and ventral (right) views of *Ophiotreta matura* (SAMC A22919).

Infraorder Ophiodermatina[10] Smith *et al*., 1995

Family OPHIODERMATIDAE Ljungman, 1867

Diagnosis *- adapted from Ljungman (1867b), Matsumoto (1917) and Clark and Courtman-Stock (1976).*
Disc closely covered with fine granules and sometimes with scattered spines. Radial shields widely separated, often concealed by disc armament, small patches may be exposed. Jaws and sometimes oral shields covered in granulation. Oral shields variable in size, usually spearhead-shaped or truncated-oval. Oral papillae numerous, in series with oral tentacle scale. Dental papillae absent. Arms broadest basally, often rectangular in cross-section, horizontally flexible. Dorsal and ventral arm plates well-developed, broadly contiguous. Arm spines short, appressed to arm, rarely as long as one segment, peg-like or conical, lowermost often flattened and / or spatulate. Tentacle pores small to moderate in size. Tentacle scales usually two, oval with the shorter outer scale overlapping base of lowest arm spine.

***Genus Cryptopelta* H.L. Clark, 1909**

Diagnosis *- adapted from Clark (1909).*
Disc, radial shields, interradial areas, oral shields, adoral shields and arm bases usually covered in fine granules. Arm spines up to seven, short and appressed. Oral papillae numerous, distal papillae wide and blunt, proximal papillae sharp and narrow. Teeth few, narrow. Genital slits two per interradius. Tentacle scales one.

***Cryptopelta aster* (Lyman, 1879)**
Figs 6.240 and 6.241.

Ophiopeza aster Lyman, 1879: 50, pl. 14, figs 395-397, Lyman, 1882: 12, pl. 21, figs 16-18.
Cryptopelta aster Clark, 1909: 131; Clark, 1923: 350-351; Mortensen, 1933c: 376-379, figs 78a, 79a, 80a, d, pl. 19, fig. 21; Clark and Courtman-Stock, 1976: 106, 124, 182, fig. 204.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 13mm, D.D./ A.L. = 1/3. Disc pentagonal, flat, covered dorsally and ventrally in fine granules extending onto basal arm segments. Granules covering adoral shields, jaws and oral shields, granulation on jaws slightly coarser. Oral papillae eight or nine, in series with second oral tentacle scale, proximal-most papillae narrower and more pointed, distalmost ones broad. Madreporite naked. Genital slits one, not reaching disc margin. Dorsal arm plates fan-shaped, broadest near middle, wider than long, distal edge convex. Ventral arm plates bell-shaped, distal edge convex. Arm spines up to seven, sometimes eight, less than half segment length. Tentacle scale one, oval. Colour in life cream or orange to brick-red on the disc, orange and red, mottled, arms banded.

Distribution and habitat
South Africa: Cape Town (WC) to off Shaka's Rock (KZN); depth range: 75-421m.
Habitat: Rock, shell, sand and coral.

[10] Smith *et al.* (1995) erected a new infraorder based on morphological, molecular and fossil data, however, they did note that it should be considered as *sedis mutabilis* within any classification.

Remarks
The records from Sulu Islands (Philippines) and Pternoster Islands (Indonesia) cited by Clark (1909) are unconfirmed as they are not cited anywhere else. Therefore, *Cryptopelta aster* may be endemic to South Africa.

The type material is in the Museum of Comparative Zoology (syntype: MCZ OPH-155), type locality is Agulhas Bank, depth 274m.

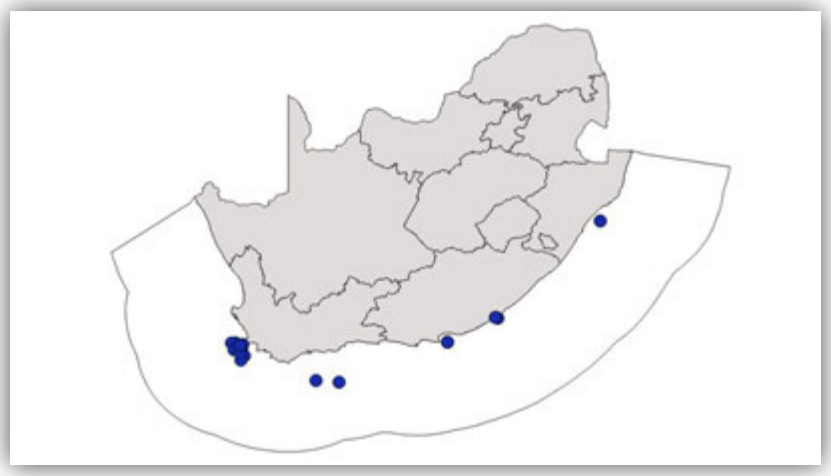

Figure 6.240. Distribution of *Cryptopelta aster* in South Africa.

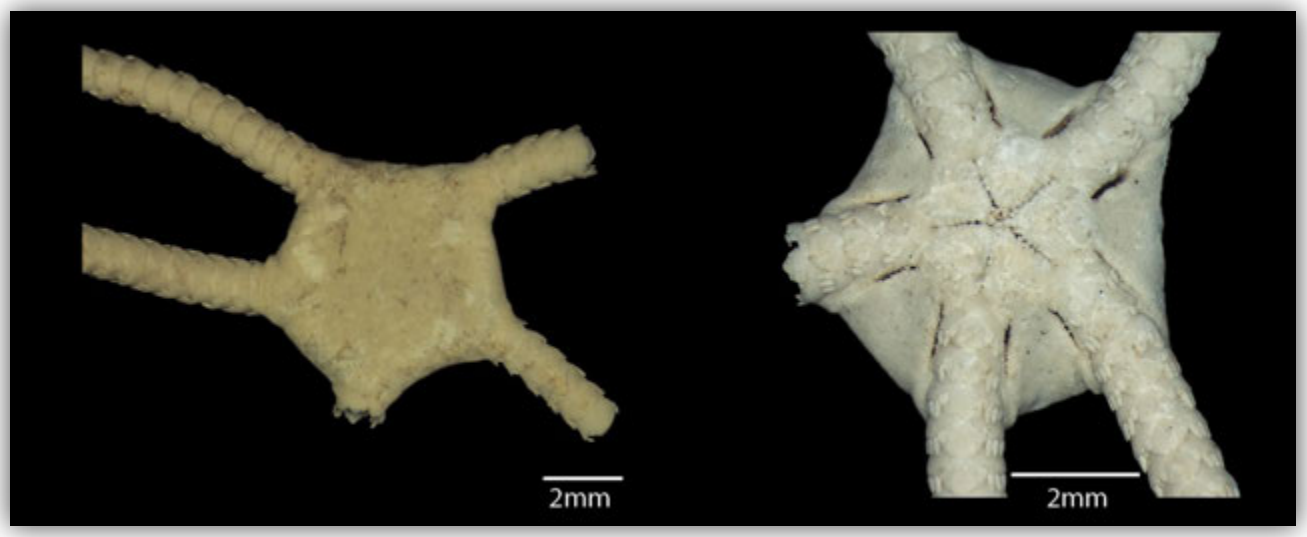

Figure 6.241. Dorsal (left) and ventral (right) views of *Cryptopelta aster* (SAMC A23236).

Genus Ophiochaeta **Lütken, 1869**

Diagnosis *- adapted from Cherbonnier and Guille (1978) and Lyman (1882).*
Disc densely covered in small spines and or granules, radial shields concealed by same disc armament, no supplementary oral shields present. Oral papillae numerous, up to 14. Teeth various shapes, pointed, sharp or square. Genital slits two per interradius. Arm spines numerous, up to ten.

Ophiochaeta hirsuta Lütken, 1869

Figs 6.242 and 6.243.

Ophiochaeta hirsuta Lütken, 1869: 38, 71; Clark, 1915a: 222; Clark and Rowe, 1971: 127, fig. 44a, b; Gibbs *et al.*, 1976: 129; Sloan *et al.*, 1979: 115; Marsh *et al.*, 1993: 62; Rowe and Gates, 1995: 398; Price and Rowe, 1996: 78; Olbers *et al.*, 2015: 105, pl. 7A, B.
Ophiochaeta boschmai Clark, 1964: 388-340, fig. 2.

Diagnosis *- adapted from Clark and Rowe (1971) and Sloan et al. (1979).*
D.D. up to 7mm. D.D./A.L. = 1/4. Disc pentagonal, completely covered in indented granules and long, thin spinelets both dorsally and ventrally, spinelets densest on ventral interradials close to oral shields. Oral shields and adoral shields may have granules, but few if present. Radial shields concealed by granulation and spinelets. Marginal plates covered by rounded and enlarged granules, disc spines dense on disc margin. Oral shields triangular, slightly longer than wide; no supplementary oral shields. Adoral shields large, triangular, not contiguous. Oral papillae 5-6, pointed. Teeth three, lowermost bluntly pointed, second square and uppermost pointed. Genital slits single, up to half-way to margin, genital papillae absent. Dorsal arm plates triangular, distal edge straight, proximally narrowly contiguous, distally not contiguous. Ventral arm plates pentagonal, distal edge straight or somewhat convex. Arm spines up to 12, tapering, subequal, all shorter than one segment length. Tentacle scales oval, two proximally, but one along most of arm. Colour in life grey to brown, mottled, arms banded with dark brown, light brown and white.

Distribution and habitat
Western Indian Ocean, Red Sea, Indo-Malayan region, Australia, South Pacific Islands, (Clark and Rowe, 1971; Rowe and Gates, 1995; Richmond, 2002), South Africa: Sodwana Bay (KZN) to Kosi Bay (KZN); depth range: 0-26m.
Habitat: Associated with *Porites* coral colonies or on sandy gravel in lagoonal sea grass beds (Sloan *et al.*, 1979).

Remarks
Olbers *et al.* (2015) noted this species as a new record for South Africa.

Figure 6.242. Distribution of *Ophiochaeta hirsuta* in South Africa.

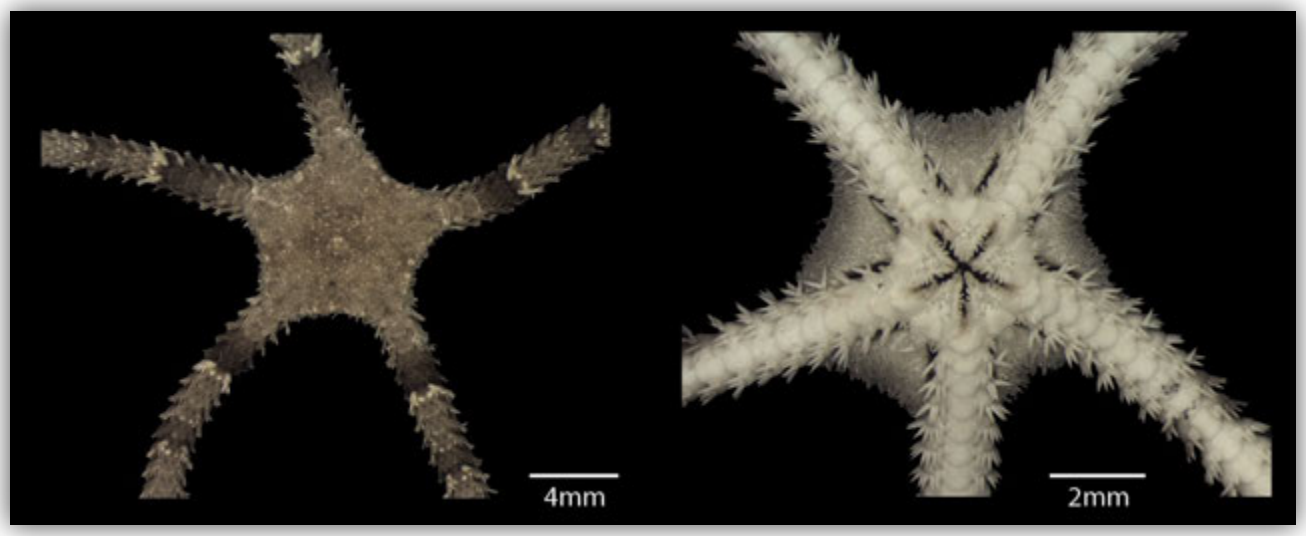

Figure 6.243. Dorsal (left) and ventral (right) views of *Ophiochaeta hirsuta* (RMCA MT2290).

Genus Ophioconis Lütken, 1869

Diagnosis *- adapted from Lütken (1869), Lyman (1882) and Cherbonnier and Guille (1978).*
Disc covered in closely-packed granules. Oral papillae numerous, up to 14. Supplementary oral shields present. Teeth few, large, blunt with translucent edges. Genital slits two per interradius. Arm spines up to nine.

Ophioconis cupida Koehler, 1905

Figs 6.244 and 6.245.

Ophioconis cupida Koehler, 1905a: 15-16, pl. 1, figs 19, 20; Clark and Rowe, 1971: 88-89, 127; Cherbonnier and Guille, 1978: 222-223, pl. 16, figs 3, 4; Marsh, 1986: 72; Vine, 1986: 195; Rowe and Gates, 1995: 399; Olbers *et al.*, 2015: 105, 107, pl. 7C, D.
Ophiurodon cupida: Matsumoto, 1915: 84; Matsumoto, 1917: 315.
Ophiurodon cupidum: Koehler, 1930: 278; Clark, H.L., 1939: 95-96; Murakami, 1943b: 213; Clark, 1946: 255.

Diagnosis *- adapted from Cherbonnier and Guille (1978).*
D.D. up to 4mm. Disc pentagonal, disc almost completely covered in granules both dorsally and ventrally. Radial shields concealed by granulation. Oral shields triangular, wider than long; supplementary oral shields present, but concealed by granulation. Adoral shields relatively large, triangular, not contiguous. Oral shields and adoral shields may have granules, but easily rubbed off. Oral papillae 5-6, pointed. Teeth three, lowermost wide, large, square, edges translucent. Genital slits single, almost up to disc margin, genital papillae absent. Dorsal arm plates fan-shaped with distal point, narrowly contiguous. Ventral arm plates pentagonal, distal edge pointed, narrowly contiguous. Arm spines up to eight, tapering, subequal, longest one slightly longer than segment length. Tentacle pores moderately large. Tentacle scales one, elongated oval, translucent. Colour grey or white with large brown patches on radial areas, arms banded with brown.

Distribution and habitat
Madagascar, Comoros, Red Sea, Bay of Bengal, China, Japan, Philippines, Australia and Pacific Islands (Cherbonnier and Guille, 1978; Rowe and Gates, 1995), South Africa: Kosi Bay (KZN); depth range: 10-600m.
Habitat: Found among sand, algae and stones.

Remarks
Olbers *et al.* (2015) noted this species as a new record for South Africa. Easily recognisable within the family by the translucent teeth and tentacle scales. See Olbers *et al.* (2015) for additional remarks. Type material is in Naturalis (ZMA.ECH.O 2004, ZMA.ECH.O 2005 and ZMA.ECH.O 2035), (Joke Bleeker, pers. comm.).

Figure 6.244. Distribution of *Ophioconis cupida* in South Africa.

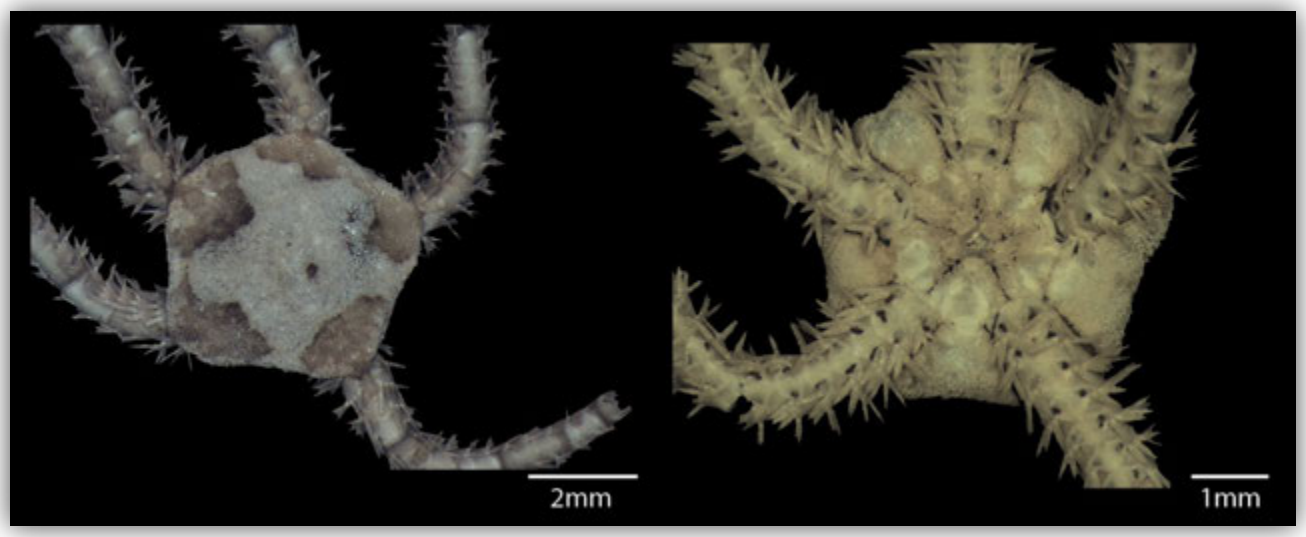

Figure 6.245. Dorsal (left) and ventral (right) views of *Ophioconis cupida* (SAMC A74041).

Genus Ophiodyscrita H.L. Clark, 1938

Diagnosis - *adapted from Clark (1938).*
Disc covered in granules extending over arms both dorsally and ventrally, as well as over the entire oral surface of disc and oral frame. Disc margin with large plates. Genital slits two per interradius. Tentacle scales two, sometimes three proximally.

Ophiodyscrita acosmeta H.L. Clark, 1938

Figs 6.246 and 6.247.

Ophiodyscrita acosmeta Clark, 1938: 356-357; Clark, 1946: 265; Clark and Rowe, 1971: 88-89, 128; Rowe and Gates, 1995: 399; Price and Rowe, 1996: 79; Lane *et al.*, 2000: 483; Marsh and Morrison, 2004: 295, 298, 302, 306, 312, 337; Olbers *et al.*, 2015: 107, pl. 7E, F.
Ophiocryptus pacificus Murakami, 1943a: 188-189, fig. 10.
Ophiostegastus compsus Clark, 1968: 317-321, fig. 10.

Diagnosis *- adapted from Clark (1938).*
D.D. up to 8mm. Disc round to pentagonal, covered with small, slightly-indented granules completely covering dorsal and ventral side. Granules on oral shields, adoral shields, supplementary oral shields and dorsal, ventral and lateral arm plates. Radial shields also concealed, some granules slightly enlarged over marginal area. Oral shields ovate to spearhead-shaped, wider than long. Oral papillae 6-7, flattened. Genital slit up to two-thirds to margin of disc. Arms slightly flattened. Dorsal arm plates D-shaped, twice as wide as long, with rounded distal edge, with two more-or-less conspicuous whitish patches on distal edge of each plate, covered with granules similar to those on disc. Ventral arm plates more-or-less rhombic, becoming bell-shaped with distal edges round, not contiguous distally. Lateral arm plates slightly projecting. Arm spines up to eight, appressed, short, less than half segment length. Tentacle scales ovate, up to three basally, inner one largest, two becoming one toward distal segments of arm. Colour in life brown and grey dorsally, ventrally lighter, dorsal disc patchy light and dark, arms with dark bands of 3-5 segments.

Distribution and habitat
China, Japan and Australia (Clark and Rowe, 1971), South Africa: Sodwana Bay (KZN); depth range: 0-23m.
Habitat: No information available.

Remarks
Olbers *et al.* (2015) noted this species as a new record for South Africa.

The type material is in the Museum of Comparative Zoology (holotype: MCZ OPH-5294), type locality is Broome, Australia, depth unknown.

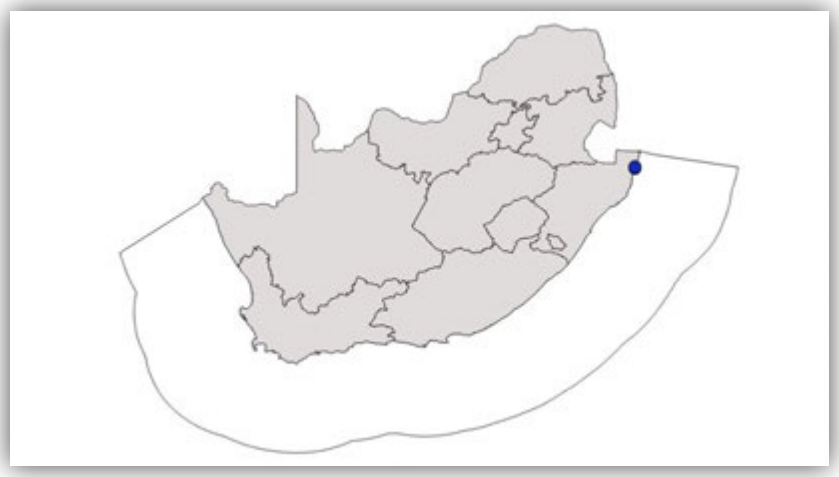

Figure 6.246. Distribution of *Ophiodyscrita acosmeta* in South Africa.

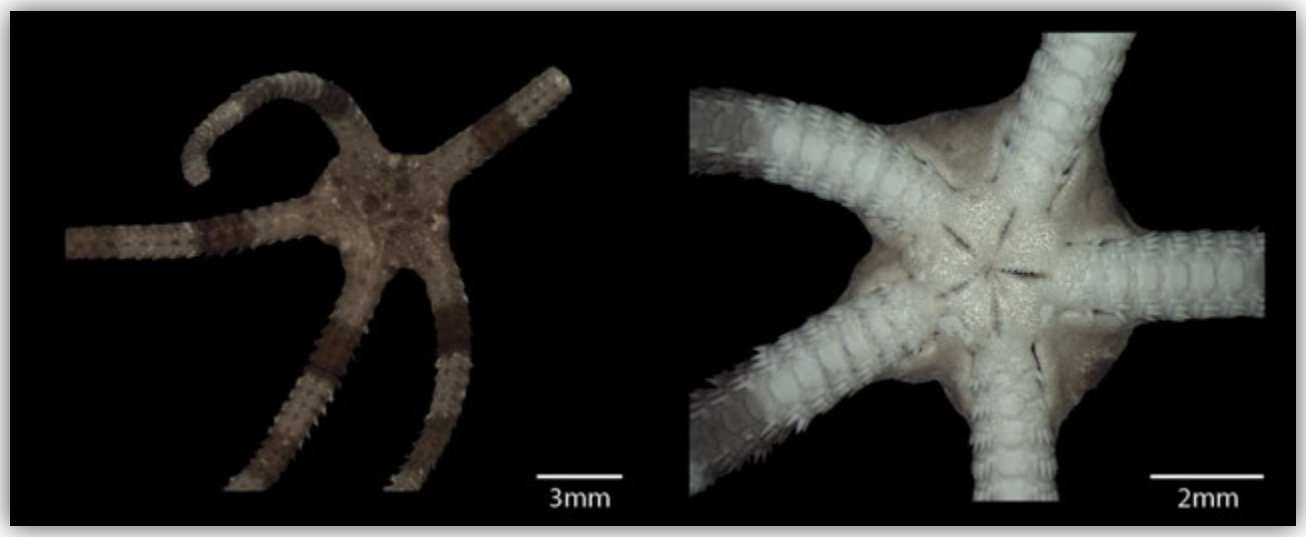

Figure 6.247. Dorsal (left) and ventral (right) views of *Ophiodyscrita acosmeta* (RMCA MT2183).

Genus Ophiopeza Peters, 1851

Diagnosis *- adapted from Peters (1851), Lyman (1882) and Vail and Rowe (1989).*
Disc granulated, scales coarse, overlapping. Marginal scales enlarged, usually covered in granules. Radial shields obscured by granules. Jaws covered in granules. Oral shields naked, supplementary oral shields present. Genital slits two per interradius. Dorsal arm plates fan-shaped to rectangular, arm spines never exceeding single segment length, usually appressed. Tentacle scales one or two; smaller scale covering or overlapping base of lowest arm spine.

Ophiopeza fallax fallax Peters, 1851

Figs 6.248 and 6.249.

Ophiopeza fallax: Peters, 1851: 465-466; Lyman, 1865: 39; Ljungman, 1867b: 305; Lyman, 1874: 221; Studer, 1882: 4; Lyman, 1882: 13; De Loriol, 1893a: 4, pl. 23, fig. 1; Clark and Rowe, 1971: 90-91, 127; Clark and Courtman-Stock, 1976: 106, 124, 184; Cherbonnier and Guille, 1978: 225-226, pl. 17, figs 1, 2; Sloan *et al.*, 1979: 115; Tortonese, 1980: 129; Vine, 1986: 195; Mbongwa, 2013: 16.
Pectinura fallax: Clark, 1909: 119; Clark, 1915a: 303, pl. 18, figs 9, 10; Koehler, 1930: 270.
Ophiopezella decorata Mortensen, 1933c: 379-380, fig. 81, pl. 19, fig. 24; Balinsky, 1957: 28; Kalk, 1958: 238; Macnae and Kalk, 1969: 106, 130.
Ophiopeza fallax fallax: Clark, 1968: 312-313, fig. 9c; Vail and Rowe, 1989: 275, fig. 4.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 15mm; D.D/A.L. = 1/3-3.5. Disc pentagonal, covered in dense coat of granules, closely packed up to oral shields (seldom on oral shields), extending onto jaws and basal dorsal arm segments. Marginal scales few, large and puffy. Radial shields concealed by granulation. Oral shields truncated, oval, wider than long, marbled white and brown; supplementary oral shields distal to each oral shield, small, normally covered by granulation. Adoral shields present, relatively small and usually covered in granules. Oral papillae 8-9. Oral tentacle scale single. Teeth four, lowermost squarish, becoming pointed. Genital slits almost reaching disc margin, no genital papillae but disc granulation continues up to genital slits. Dorsal arm plates broadly fan-shaped, wider than long, round distal edge becoming narrowly contiguous distally. Ventral arm plates fan-shaped, but distal edge angle more obtuse than for dorsal arm plates. Arm spines up to 13, conical, short, lowest spine longest, barely as

long as segment length if at all, more or less appressed to arm. Tentacle scales two basally, inner one relatively large, ovate becoming pointed at distal end of arm, almost twice as long as outer one. Colour, disc grey to brown, mottled, sometimes with patchy patterns, arms banded.

Distribution and habitat

Mozambique, Tanzania, Madagascar, Philippines (Clark and Rowe, 1971; Cherbonnier and Guille, 1978), South Africa: Aliwal Shoal (KZN) to Bhanga Nek (KZN); depth range: 0-64m.
Habitat: Under boulders over sand, under stones, on reef.

Remarks

Distribution range in South Africa here extended from Durban (from synonym *Ophiopezella decorata*) south to Aliwal Shoal (see Table 7.3). Syntype in the Museum of Natural History at the University of Berlin (ZMB Ech 973). The type locality is Quirimbas Island, Mozambique, depth unknown.

Figure 6.248. Distribution of *Ophiopeza fallax fallax* in South Africa.

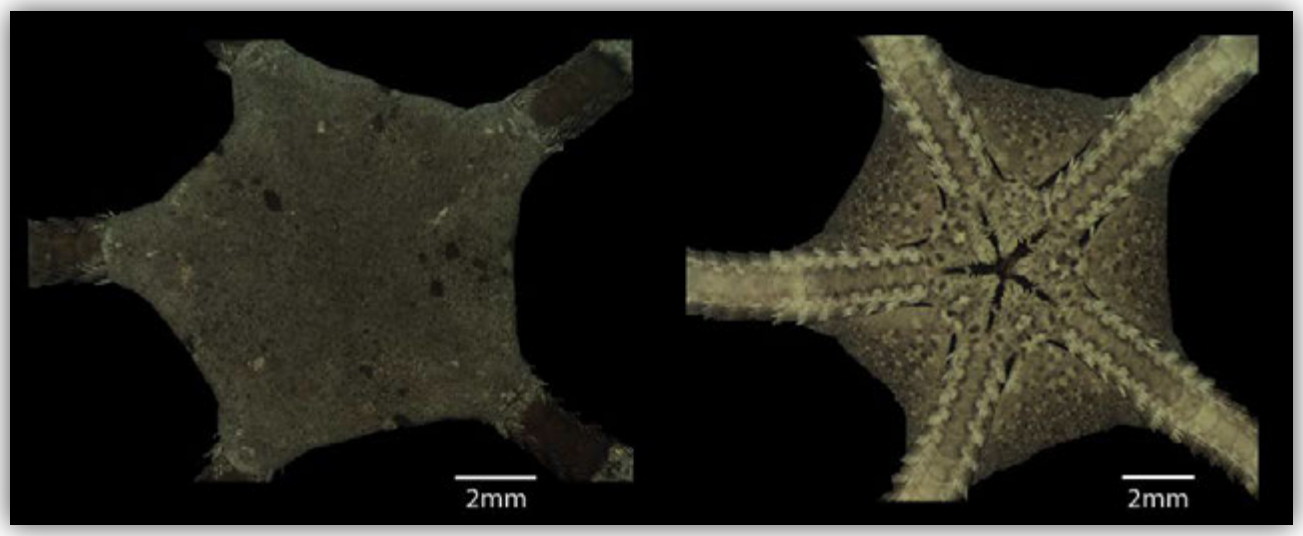

Figure 6.249. Dorsal (left) and ventral (right) views of *Ophiopeza fallax fallax* (RMCA MT2251).

Ophiopeza spinosa (Ljungman, 1867)

Figs 6.250 and 6.251.

Ophiarachna spinosa Ljungman, 1867b: 305.
Ophiopeza fallax Lütken, 1869 (non Peters, 1851): 35.
Ophiopezella dubiosa De Loriol, 1893a: 7, pl. 23, fig. 2; Clark, 1909: 120; Clark, 1915a: 304.
Ophiopezella luetkeni De Loriol, 1893b: 392-394, pl. 13, fig. 1.
Ophiopeza dubiosa: Clark, 1968: 313.
Ophiopeza spinosa: Clark and Rowe, 1971: 90-91, 127, fig. 44e; Gibbs *et al.*, 1976: 130; Cherbonnier and Guille, 1978: 227-228, pl. 17, figs 3, 4; Tortonese, 1980: 129; Humpreys, 1981: 10; Marsh, 1986: 71; Vine, 1986: 195; Vail and Rowe, 1989: 273-275, fig. 3; Marsh *et al.*, 1993: 62; Liao and Clark, 1995: 285-286, fig. 159; Rowe and Gates, 1995: 400-401; Mbongwa, 2013: 16; Olbers *et al.*, 2015: 107, 109, pl. 8A, B.
Ophiopezella spinosa: Clark, 1909: 120; Clark, 1915a: 304; Clark, 1921: 141; Koehler, 1922b: 338-339; Clark, 1946: 258.
Distichophis clarki Ely, 1942: 46-48, fig. 12.

Diagnosis - *adapted from Cherbonnier and Guille (1978).*

D.D. up to 11mm. Disc pentagonal, covered with dense coat of small, indented granules, closely packed up to oral shields, extending onto jaws. Disc margin with small, inflated plates in interradial areas. Radial shields concealed by granulation. Oral shields spearhead-shaped, supplementary oral shields not covered by granulation, adoral shields present, relatively large, not contiguous, not distinct, covered in granules. Oral papillae 6-7, elliptical leaf-shaped, pointed but blunt. Teeth four. Genital slits reach half-way to disc margin, genital papillae absent. Dorsal arm plates broadly fan-shaped basally, wider than long, but rounded on distal edge, becoming more typical fan-shaped distally, not contiguous distally. Ventral arm plates bell- or fan-shaped, narrowly contiguous. Arm spines up to 12, conical, short, half segment length, slightly longer basally, appressed. Tentacles scales two for most of arm length, inner one large, ovate, almost twice as long as outer one. Colour in life, disc grey to brown yellow, sometimes with patchy patterns, arms banded and marbled.

Distribution and habitat

Western Indian Ocean, Mauritius, Aldabra, Seychelles, Red Sea, Mascarene Basin, South East Polynesia, Hawaii (Tortonese, 1980; Rowe and Gates, 1995), South Africa: Leadsman Shoal (KZN) to Kosi Bay (KZN); depth range: 0-74m.
Habitat: Found under rocks and coral rubble, among mixed algae and on coral reefs.

Remarks

Olbers *et al.* (2015) noted this species as a new record for South Africa. The syntypes are in the Swedish Museum of Natural History (*Ophiarachna spinosa*: SMNH-Type-1424) and the type locality is Foa, Tonga, depth unknown.

Figure 6.250. Distribution of *Ophiopeza spinosa* in South Africa.

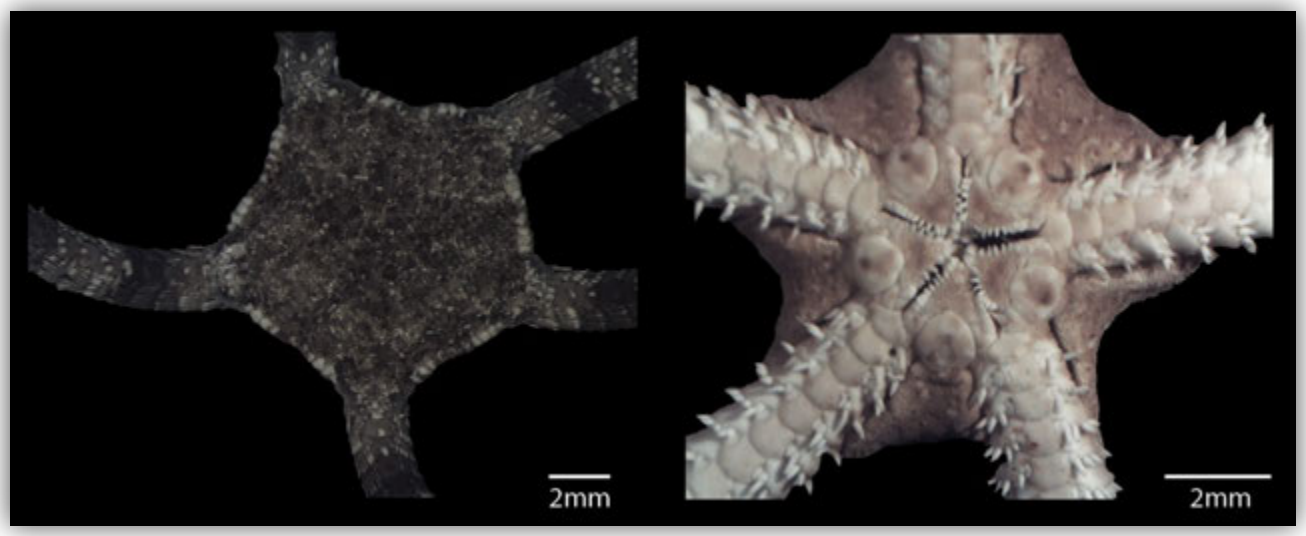

Figure 6.251. Dorsal (left) and ventral (right) views of *Ophiopeza spinosa* (RMCA MT2284).

Genus Ophiarachna Müller and Troschel, 1842

Diagnosis - *adapted from Müller and Troschel (1842) and Lyman (1882).*
Disc granulated, including radial shields. Supplementary oral shields present. Oral papillae numerous and close-set. Teeth in vertical series. Genital slits two per interradius. Arm spines long, erect, usually 4-6, smooth. Tentacle scales 1-2.

Ophiarachna affinis Lütken, 1869

Figs 6.252 and 6.253.

Ophiarachna affinis Lütken, 1869: 34, 98; De Loriol, 1893b: 411-413; Koehler, 1904b: 76-77; Clark, 1909: 128; Clark, 1915b: 299, pl. 18, figs 1, 2; Koehler, 1922b: 333-335, pl. 4, fig. 1; Koehler, 1930: 271-272, pl. 14, fig. 1; Clark and Rowe, 1971: 88-89, 123, fig. 42a; Devaney, 1974: 175-176; Sloan *et al.*, 1979: 111, figs 17, 18; Marsh, 1986: 71; Rowe and Gates, 1995: 395; Olbers *et al.*, 2015: 109, pl. 8C, D.
Ophiarachna clavigera Brock, 1888: 495-497.

Diagnosis *- adapted from Devaney (1974).*
D.D. up to 28mm. Disc round, somewhat puffy, densely covered in round granules both dorsally and ventrally, granules extending onto oral plates. Radial shields not distinct. Oral shields naked, spearhead-shaped with marbled patterns, single supplementary plate, naked, half width of oral shield. Adoral shields small, not contiguous. Oral papillae 5-6, shape varies, broad, thin, elliptical leaf-shaped, middle papillae more slender than proximal and distal ones. Oral tentacle scales three, deep in mouth. Teeth five, lowest tooth square becoming pointed. Genital slits long, reaching edge of disc margin, genital papillae absent, but disc granules up to edge of slit. Arm spines up to five, lowermost spine flattened and blunt, others flattened, but conical or tapering, twice segment length, basally lowermost arm spines may reach 3-4 times segment length. Dorsal arm plates rectangular, with slight distal concave notch on distal side, twice as wide as long proximally, becoming equal distally. Ventral arm plates square to fan-shaped proximally, becoming longer than wide distally, distal edges slightly convex, plates have thin lighter-coloured margin along whole arm length. Tentacle scales two, oval, outer one somewhat rectangular. Colour in life, disc brown and grey with widely-spaced spots both dorsally and ventrally, arms banded with broad dark and light brown bands of 4-9 segments, with four longitudinal dark lines down length of arm. Arm spines annulated with grey and brown.

Distribution and habitat
Mozambique, Aldabra, Seychelles, Red Sea in East Indies, Philippines, Indonesia, Australia, Fiji, Samoa, South Pacific Islands (Clark, 1909; Clark and Rowe, 1971; Rowe and Gates, 1995; Richmond, 2002), South Africa: Sodwana Bay (KZN); depth range: 0-31m.
Habitat: Under *Porites* colonies over sandy gravel, under boulders over sand and rubble and among coral rubble.

Remarks
Apart from the different oral configuration, this species is similar in colouration to *Ophiocoma* (*Breviturma*) *doederleini,* but distinguished by the presence of four longitudinal dark lines along arms.

Olbers *et al.* (2015) noted this species as a new record for South Africa.

Type material is in the Museum of Natural History at the University of Berlin (syntype of *Ophiarachna clavigera*: ZMB Ech 5430) and the type locality is Amboina, Indonesia, depth unknown.

Figure 6.252. Distribution of *Ophiarachna affinis* in South Africa.

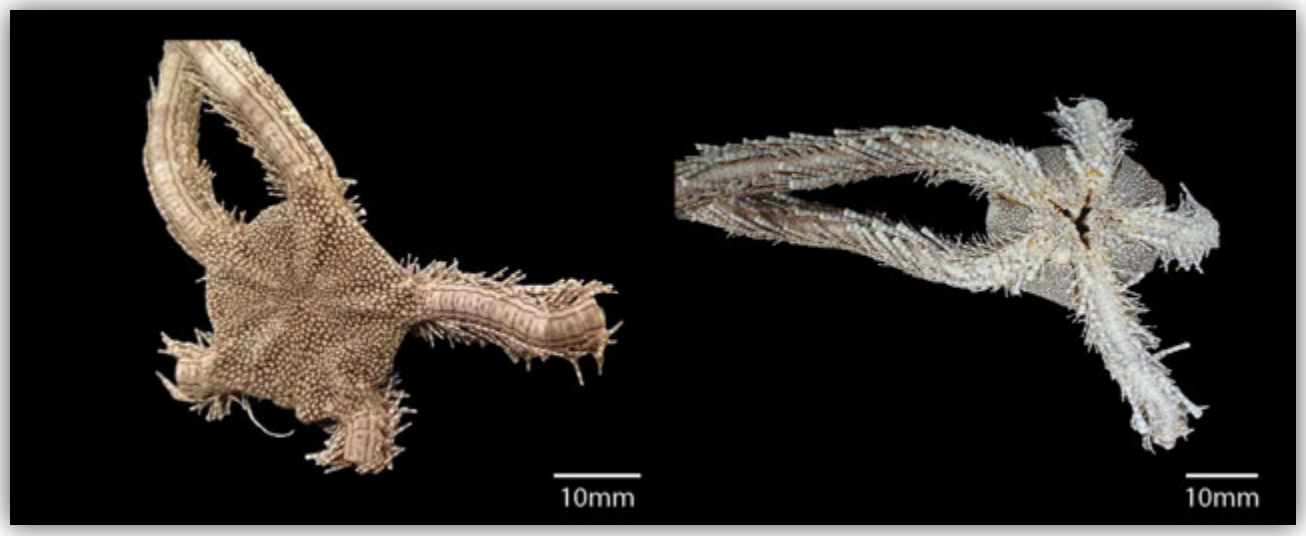

Figure 6.253. Dorsal (left) and ventral (right) views of *Ophiarachna affinis* (SAMC A28132).

Genus Ophiarachnella Ljungman, 1872

Diagnosis *- adapted from Ljungman (1872) and Clark (1909).*
Disc granulated. Radial shields naked. Oral shields large, naked. Supplementary oral shields present, naked. Oral papillae large, numerous and close-set. Teeth in vertical series. Genital slits two per interradius. Arm spines smooth, more than five, shorter than arm segments. Tentacle scales two.

Ophiarachnella capensis (Bell, 1888)

Figs 6.254 and 6.255.

Pectinura capensis Bell, 1888: 282, pl. 16, figs 3, 4.
Ophiarachnella capensis: Clark, 1923: 351; Mortensen, 1933c: 380-381, fig. 82, Stephenson *et al.*, 1937: 380; Stephenson *et al.*, 1938: 18; Stephenson, 1944: 347; Clark, 1955: 24, fig. 4b; Day, 1959: 544; Day, 1969: 184; Day *et al.*, 1970: 81; Clark and Courtman-Stock, 1976: 106, 124, 182, fig. 200, 205; Olbers *et al.*, 2014: 17, pl. 3D.

Diagnosis *- adapted from Mortensen (1933c) and Clark and Courtman-Stock (1976).*
D.D. up to 19mm, D.D./A.L. = 1/5. Disc covered both dorsally and ventrally by granules. Radial shields naked, oval or pear-shaped, longer than wide. Oral shields naked, triangular or spearhead-shaped. Supplementary oral shields naked, as wide as oral shield. Adoral shields small, with slightly less granules, not contiguous. Jaws and / or oral plates covered in granules, slightly coarser than disc granules. Oral papillae 7-8, in series with the second oral tentacle scale, proximal papillae becoming narrower and pointed. Dorsal arm plates hexagonal, broadest near their distal ends, distal edge slightly convex, broadly contiguous. Ventral arm plates square with distal edge convex, broadly contiguous. Arm spines up to seven, short and conical, lowest less than half segment length. Tentacle scales two, oval. Colour, irregular dark spot or blotch in middle of disc, arms banded with broad bands.

Distribution and habitat
Vema Seamount (Clark and Courtman-Stock, 1976), South Africa: Langebaan (WC) to Kosi Bay (KZN); depth range: 0-92m.
Habitat: Rock, sand, shell and under stones.

Remarks
Range here extended from Cape Town to Langebaan to the west and from Amatikulu (KZN) to Kosi Bay (KZN) to the east (see Table 7.3). The type locality is Cape of Good Hope, depth unknown.

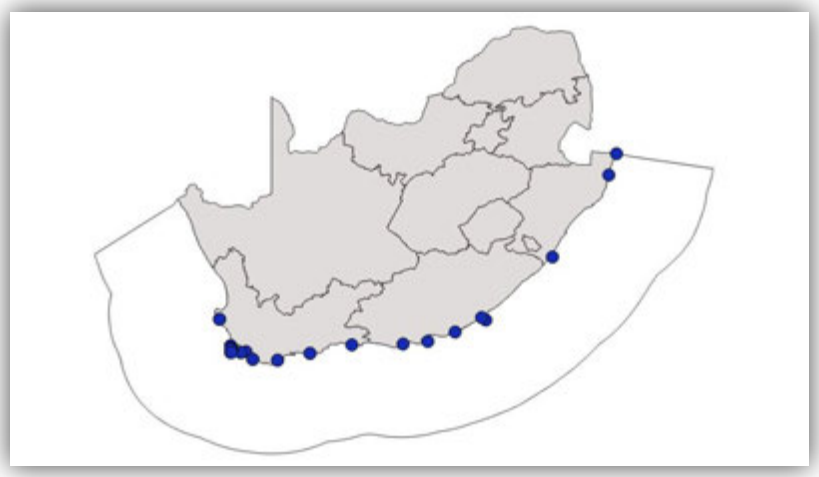

Figure 6.254. Distribution of *Ophiarachnella capensis* in South Africa.

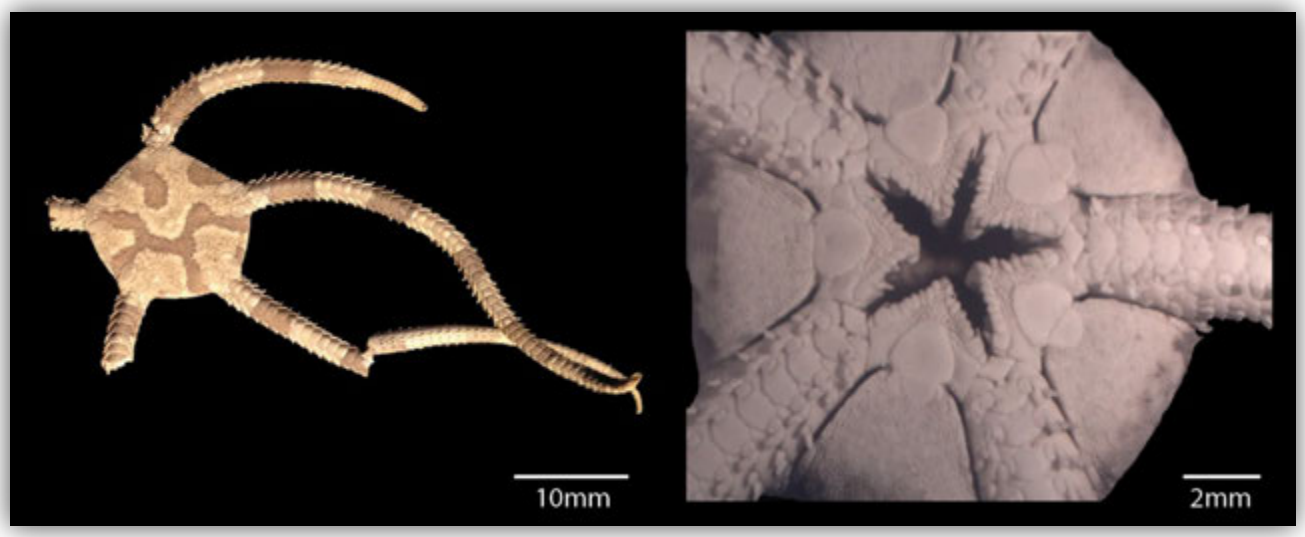

Figure 6.255. Dorsal (left) and ventral (right) views of *Ophiarachnella capensis* (SAMC A084228).

***Ophiarachnella gorgonia* (Müller and Troschel, 1842)**

Figs 6.256 and 6.257.

Ophiarachna gorgonia: Müller and Troschel, 1842: 105.
Pectinura gorgonia: Lütken, 1869: 15; Lyman, 1882: 15; Koehler, 1898b: 59, pl. 2, figs 1, 2.
Pectinura marmorata Lyman, 1874: 222, pl. 5, figs 1-7.
Pectinura venusta De Loriol, 1893a: 16-19, pl. 23, fig. 3.
Ophiarachnella gorgonia: Clark, 1909: 123-124; Matsumoto, 1917: 323-324, pl. 6, fig. 7; Clark, 1921: 141-142, pl. 12, fig. 5, pl. 35, figs 4, 5; Koehler, 1922b: 339-340; Clark, 1932: 209; Clark, 1946: 260-261; Clark, 1965: 66; Clark and Rowe, 1971: 88, 125, fig. 42b, pl. 20, fig. 2; Cherbonnier and Guille, 1978: 217-218, pl. 15, figs 5, 6; Sloan *et al.*, 1979: 111; Tortonese, 1980: 129; Humpreys, 1981: 10; Irimura, 1982: 66, 67, fig. 39, pl. 13, fig. 6; Guille and Vadon, 1985: 64; Marsh *et al.*, 1993: 62; Liao and Clark, 1995: 281-282, fig. 156, pl. 19, figs 2, 3; Rowe and Gates, 1995: 396; Putchakarn and Sonchaeng, 2004: 423; Olbers *et al.*, 2015: 109-110, pl. 8E, F.
Ophiarachnella marmorata: Clark, 1915a: 305.

Diagnosis *- adapted from Cherbonnier and Guille (1978).*
D.D. up to 19mm. Disc round, with slight indentations on both sides at base of arms, covered in rounded granules dorsally and ventrally, peripheral granules slightly elongated. Radial shields naked,

ovate, longer than wide, relatively small. Granules on ventral interradial areas closely packed up to oral shields and onto jaws. Oral shields naked, pentagonal, large, supplementary oral shields distal to each oral shield, D-shaped, often equal to length of oral shield. Adoral shields small, not contiguous, triangular. Oral papillae oval and flattened, distalmost broadest. Teeth 4-5, lowermost square, others pointed. Genital slits reach disc margin, genital papillae absent, but disc granulation to slit edge. Arms triangular in cross section for more than half arm length. Arm spines up to 11, appressed to arm, tapering, approximately half segment length. Dorsal arm plates elliptical proximally, twice as wide as long, broadly in contact, becoming fan-shaped and narrowly in contact in distal parts. Distal edge on proximal-most segments sometimes scalloped. Ventral arm plates hexagonal, distal edge convex, becoming flattened distally, wider than long proximally, but longer than wide distally. Tentacle scales two for most of arm length, inner one oval and long, outer one rectangular and slightly pointed. Colour in life, disc green, brown and white with patches both dorsally and ventrally, radial shields may be mottled white, arms banded dark green and white, ventrally uniformly white, with white patches on interradial areas. Arm spines similar in coloration to arm segments.

Distribution and habitat

Western Indian Ocean and associated islands, Red Sea, East Indies, Sri Lanka, Bay of Bengal, Thailand, China, Japan, Philippines, Australia and South Pacific Islands (Clark and Rowe, 1971; Rowe and Gates, 1995), South Africa: Aliwal Shoal (KZN) to Kosi Bay (KZN); depth range: 0-50m.
Habitat: Under *Porites* colonies over gravel, beneath encrusting coral colonies, rubble and among algae.

Remarks

Hoareau *et al.* (2013) found three clades within *O. gorgonia*, two from the Western Indian Ocean. Based on the colour morphology, it is believed that this species is from Hoareau's lineage number two (Tim O'Hara, pers. comm.). However, sequencing the South African *O. gorgonia* specimens would be required to confirm these findings. Olbers *et al.* (2015) noted this species as a new record for South Africa.

The type material is in the Museum of Comparative Zoology (paratype: MCZ OPH-135), type locality is Bohol, Philippines, depth 14-18m.

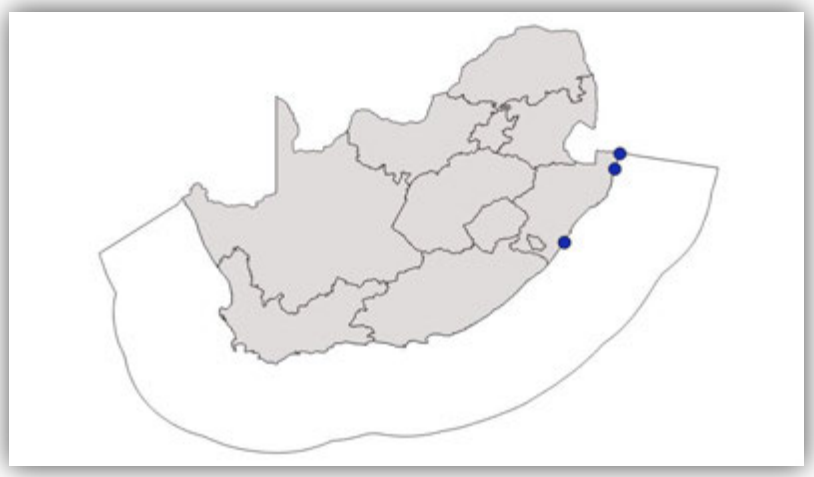

Figure 6.256. Distribution of *Ophiarachnella gorgonia* in South Africa.

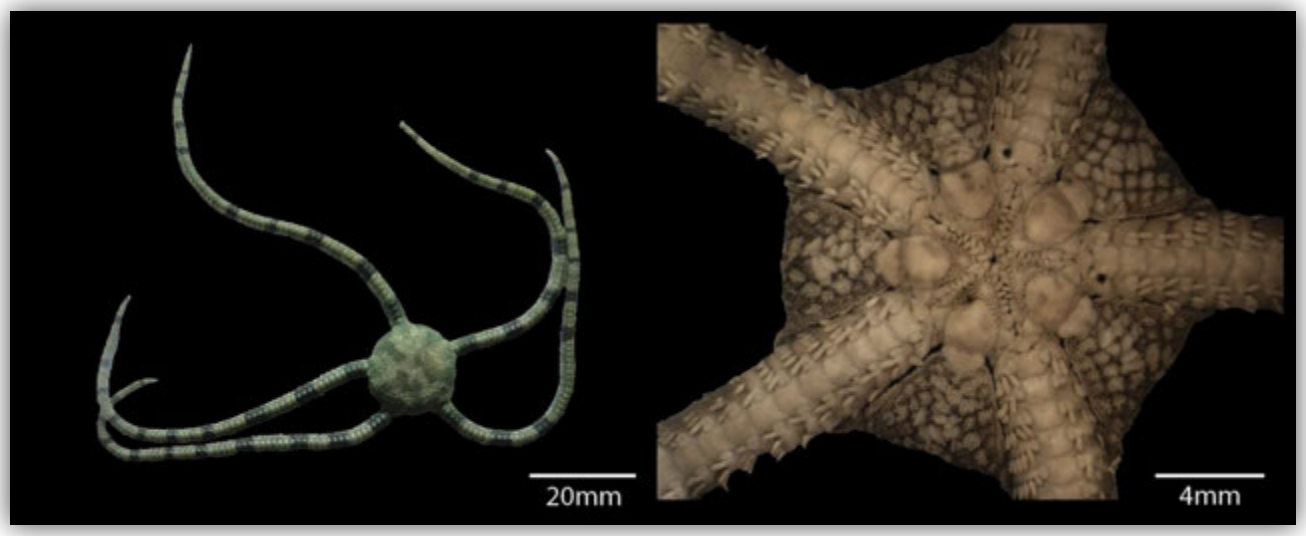

Figure 6.257. Dorsal (left) and ventral (right) views of *Ophiarachnella gorgonia,* SAMC A081608 (dorsal); RMCA MT2144 (ventral).

Ophiarachnella septemspinosa (Müller and Troschel, 1842)

Figs 6.258 and 6.259.

Ophiarachna septemspinosa Müller and Troschel, 1842: 105-106.
Pectinura septemspinosa Lütken, 1869: 33; Lyman, 1882: 17; De Loriol, 1893b: 395, pl. 13, fig. 2; Koehler, 1905a: 9.
Pectinura rigida Lyman, 1874: 224.
Ophiarachna armata Troschel, 1879: 137-138.
Ophiarachnella septemspinosa: Clark, 1909: 126; Koehler, 1930: 273; Clark, 1938: 349-350; 1946: 263-264; Cherbonnier and Guille, 1978: 218-219, pl. 16, figs 1, 2; Humpreys, 1981: 10; Guille and Vadon, 1985: 64; Marsh, 1986: 71; Marsh *et al.*, 1993: 62; Rowe and Gates, 1995: 397; Mbongwa, 2013: 16; Olbers *et al.*, 2015: 110-112, pl. 9A, B.

Diagnosis *- adapted from Cherbonnier and Guille (1978).*
D.D. up to 38mm. Disc round, flat, densely covered in granules both dorsally and ventrally, extending onto jaws. Radial shields naked, contrasting in colour with disc, very small, circular. Oral papillae 3-4, elliptical, slightly pointed. Teeth broad, but not square. Oral shields naked, oval but truncated distally by large supplementary oral shield, as wide as oral shield, some specimens have marbled oral shields. Adoral shields small, not contiguous. Genital slits long and reaching edge of disc margin, genital plate distinct and slightly higher than interradial area. Dorsal arm plates elliptical-rectangular, more than twice as long as wide, rounded lateral angles, proximal edges straight, distal margins may appear scalloped due to colouration. Ventral arm plates hexagonal, convex distally, somewhat concave proximally, wider than long, becoming longer toward distal end of arm, tentacle pore indenting lateral edges. Arm spines up to nine, conical or tapering, same length as segment with exception of lowermost arm spine, which is twice as long as segment, cigar-shaped, flattened and square-tipped. Tentacle scales two, oval, outer one somewhat broader than inner, becoming one distally. Colour in life uniformly grey, red, yellow or greenish, ventrally lighter, arms lightly banded.

Distribution and habitat
Western Indian Ocean and associated islands, Red Sea, Maldives, East Indies, China, South Japan, Philippines, Australia (Clark and Rowe, 1971; Cherbonnier and Guille, 1978; Rowe and Gates, 1995; Richmond, 2002), South Africa: Protea Banks (KZN) to Kosi Bay (KZN); depth range: 0-55m.
Habitat: Found under boulders and coral (*Millepora* spp) colonies.

Remarks
Easily recognisable by the small radial shields and striking colours. The South African specimens are "very red" in comparison to the Australian red specimens and may represent a cryptic species complex (Tim O'Hara, pers. comm.).

Olbers *et al.* (2015) noted this species as a new record for South Africa.

According to Rowe and Gates (1995) the type locality is the Moluccas, Indonesia. Type material is in the Naturalis (ZMA.ECH.O 7084 and RMNH.ECH.3566; Joke Bleeker, pers. comm.).

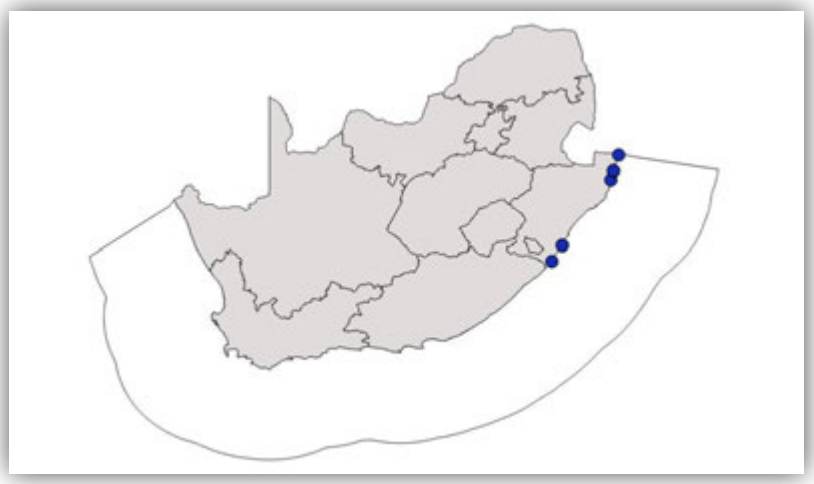

Figure 6.258. Distribution of *Ophiarachnella septemspinosa* in South Africa.

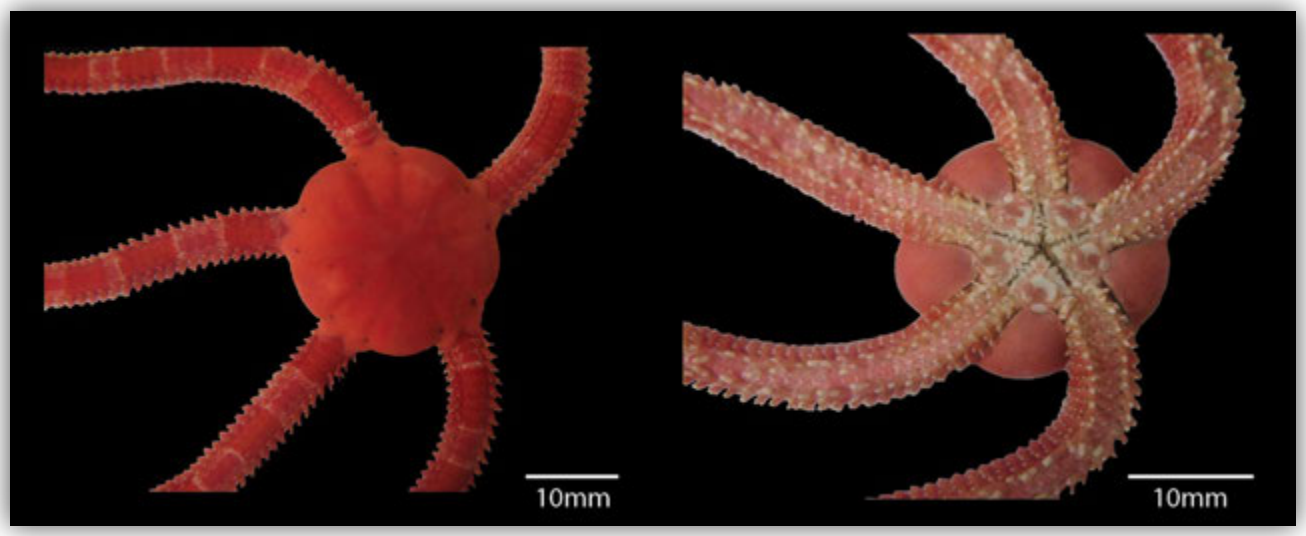

Figure 6.259. Dorsal (left) and ventral (right) views of *Ophiarachnella septemspinosa* (EKZNW LSS_4_EKZNW).

***Genus Ophiochasma* Grube, 1868**

Diagnosis *- adapted from Grube (1868) and Clark (1909).*
Disc covered in granules. Radial shields naked, very large, widely separated. Oral shields distinct, no granulation. Ventral interradial areas small. Arm spines short, rarely exceeding segment length, more or less appressed to the arm. Genital slits two per interradius. Tentacle scales two, at least basally, outer scales sometimes overlapping base of lowest arm spine.

Ophiochasma nitida Hertz, 1927

Fig. 6.260 and 6.261.

Ophiochasma nitida Hertz, 1927a: 116-117, pl. 9, figs 13, 14; Mortensen, 1933c: 216; Clark and Courtman-Stock, 1976: 106, 124, 183 and 260, fig. 267a, b.

Diagnosis *- adapted from Clark and Courtman-Stock (1976).*

D.D. up to 12mm, D.D./A.L. = 1/6. Disc covered in granules, easily rubbed off. Radial shields very large, naked, oval, widely separated, but not by more than arm width. Oral papillae 7-9, in series with second oral tentacle scale, distalmost oral papillae broader. Oral shields naked, hexagonal or elliptical leaf-shaped with rounded edges, short distal lobe, longer than wide. A disc scale that appears to be a supplementary oral shield, D-shaped, may or may not be covered in granules, longer than wide. Adoral shields naked on lateral parts, but covered in granules. Genital slits single. Dorsal arm plates broad, hexagonal, surface convex. Ventral arm plates broad, octagonal, or the three distal sides forming a continuous round edge or curve. Arm spines up to ten, short, no more than half segment length, tapering, lower spines blunter than others, appressed to arms or slightly projecting. Tentacle scales two.

Distribution and habitat

South Africa: Agulhas Bank (WC); depth range: 86-102m.
Habitat: No information available.

Remarks

Endemic to South Africa (see Table 7.4). No material was available for examination in the Iziko South African Museum collection and only three specimens are known. Type material is in the Museum of Natural History at the University of Berlin (syntype: ZMB 1623/1936 (538/1)) and the type locality is Agulhas Banks, depth 86m.

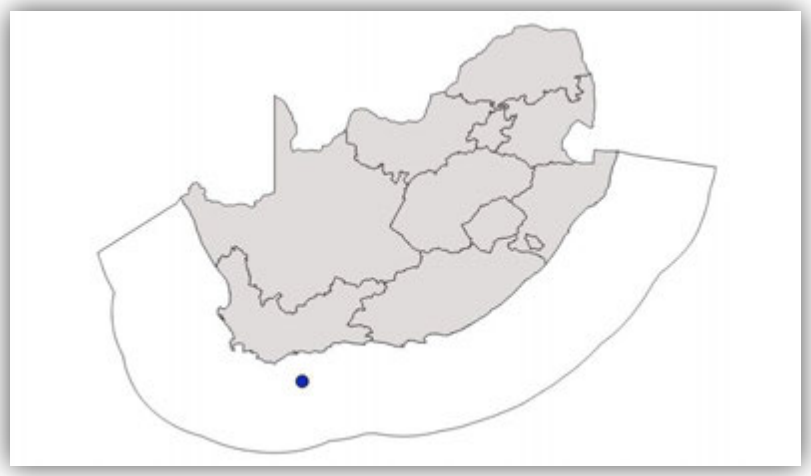

Figure 6.260. Distribution of *Ophiochasma nitida* in South Africa.

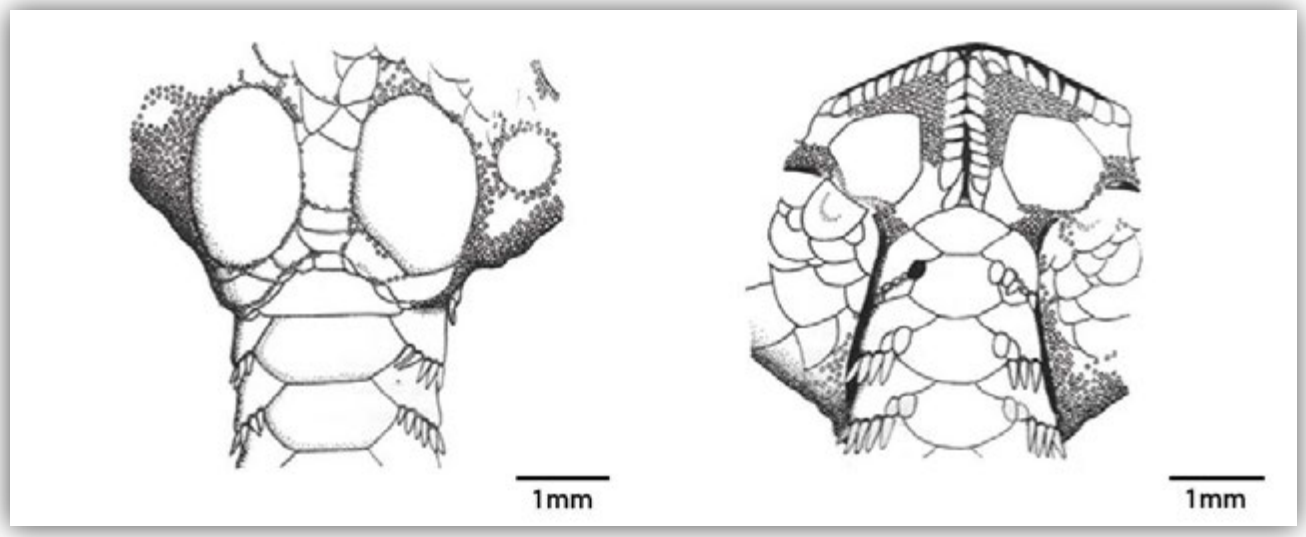

Figure 261. Dorsal (left) and ventral (right) views of *Ophiochasma nitida* (ZMB 1623/1936 (538/1), syntype, from Clark and Courtman-Stock (1976)).

Genus Ophioderma Müller and Troschel, 1840

Diagnosis - *adapted from Müller and Troschel (1840b) and Ziesenhenne (1955).*
Disc scales flat. Genital slits four per interradius. Arms more than twice length of disc.

Ophioderma wahlbergii Müller and Troschel, 1842

Figs 6.262 and 6.263.

Ophioderma wahlbergii Müller and Troschel, 1842: 87; Clark, 1923: 353; Mortensen, 1933c: 382; Ziesenhenne, 1955: 187, 189.
Ophiura wahlbergii Lyman, 1865: 10; Lyman, 1882: 10.
Ophioderma wahlbergi (*lapsus calami*): Ljungman, 1867b: 305; Clark and Courtman-Stock, 1976: 106, 124,183-184, 262-263, figs 206, 276c, d.
Ophioderma leonis Döderlein, 1910: 252-253, pl. 5, figs 1, 1a; Mortensen, 1933c: 381-382; Day, 1969: 184; Grindley and Kensley, 1966: 12; Stöhr *et al.*, 2009: 1, 18.

Diagnosis - *adapted from Clark and Courtman-Stock (1976) and Mortensen (1933c).*
D.D. up to 38mm, D.D./A.L. = 1/3. Disc round, densely covered in round, flattish granules both dorsally and ventrally, extending to oral plates or jaws. Radial shields either naked or partly naked, small, oval. Oral papillae 5-6, in series with oral tentacle scale, elliptical leaf-shaped, slightly pointed, distalmost broader, Teeth broad but not square. Oral shields naked, oval to spearhead-shaped with distal lobe, approximately as wide as long, or slightly wider. Supplementary oral shields absent. Adoral shields small, not contiguous. Genital slits two, short, no genital papillae. Arms usually five, up to seven. Dorsal arm plates elliptical rectangular, more than twice as long as wide, distal edges mostly straight, but may be slightly concave, may be divided in some basal plates. Ventral arm plates hexagonal, convex distally, as wide as long, contiguous. Arm spines up to seven (exceptionally eight or nine), conical, blunt, shorter than segment. Tentacle scales two, oval. Colour in life grey, brown, dark brown, may have patterns on disc, arms not banded, lighter ventrally.

Distribution and habitat
Namibia (Branch *et al.*, 2010), South Africa: Orange River (NC) to Danger Point (WC); depth range: 0-75m.
Habitat: Shell, sand and stones.

Remarks
Type material is in the Museum of Natural History at the University of Berlin (syntype: ZMB Ech 838 and ZMB Ech 839) and the holotype was lodged by Müller and Troschel, in the Swedish Museum of Natural History (SMNH-Type-3292). The type locality is Port Natal (Durban), depth unknown.

Numerous authors (Mortensen, 1933c; Clark, 1923 and Ziesenhenne, 1955) report that the type locality (Port Natal) is probably incorrect and that this is probably a Cape species. Given the specimens collected up to now, which have all been from Atlantic waters in the Western and Northern Cape, the record from KZN is considered incorrect. This species is endemic to the region, also being found in Namibia.

Stöhr *et al.* (2009) referred to a South African ophiodermatid as *Ophioderma leonis,* however, this had been synonymised by Clark and Courtman-Stock (1976), based on the syntypes of Döderlein's *Ophioderma leonis*.

The reproduction and brooding behaviour of this species has been comprehensively studied by Landschoff (2014), Landschoff *et al.* (2015) and Landschoff and Griffiths (2015).

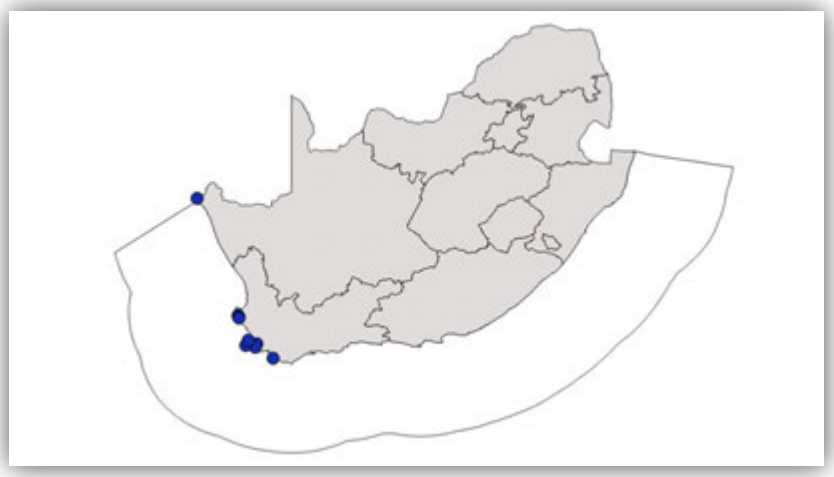

Figure 6.262. Distribution of *Ophioderma wahlbergii* in South Africa.

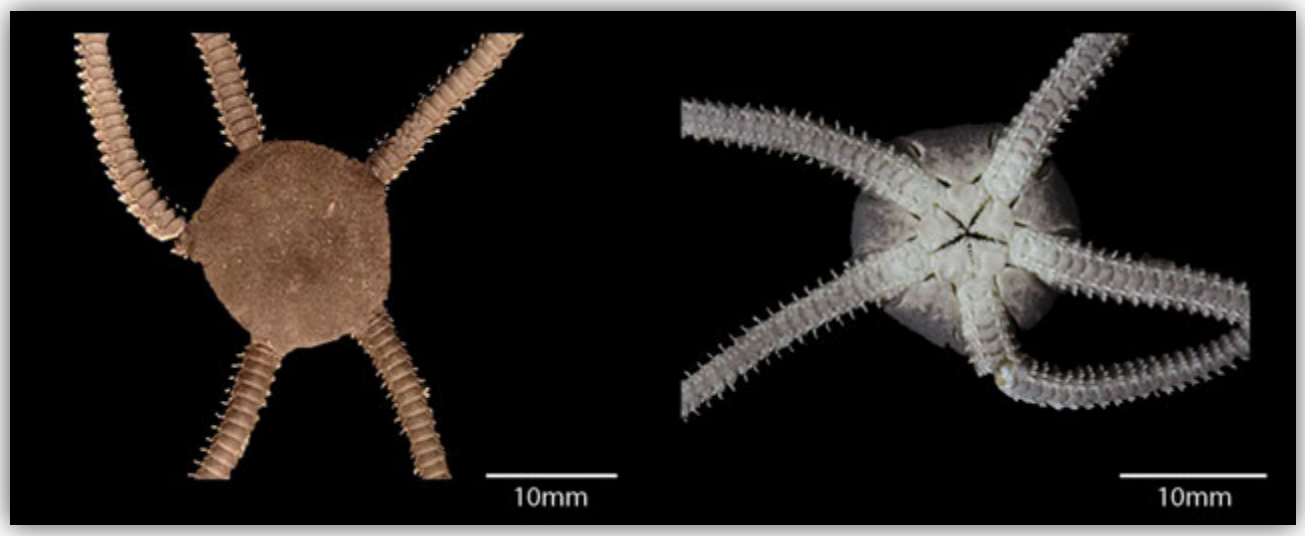

Figure 6.263. Dorsal (left) and ventral (right) views of *Ophioderma wahlbergii* (SAMC A084232).

Infraorder Ophiolepidina (Ljungman, 1867)

Family OPHIOLEPIDIDAE Ljungman, 1867

Diagnosis *- adapted from Ljungman (1867b) and Mortensen (1927).*
Disc covered in thick scales, primary rosette usually distinct. Radial shields distinct. Oral papillae in continuous series with single row of teeth, no dental papillae, usually apical papillae present. Arm combs may be present. Arms short to moderate. Dorsal and ventral arm plates distinct. Arm spines usually short and appressed to arms. Tentacle scales variable in number.

Genus *Anophiura* H.L. Clark, 1939

Diagnosis *- adapted from Clark, H.L. (1939).*
Disc flat and thin, interradial disc scales large, five marginal scales in each interradial. Arms slender. Dorsal and ventral arm plates small. Arm combs may or may not be present. Oral shields, adoral shields and oral plates large, covering most of interradial area. Oral papillae low, wide, quadrilateral. Genital slits two per interradius. Tentacle pores only three pairs on each arm, first pair with two low, wide tentacle scales, other two pairs with single, circular tentacle scale.

***Anophiura simplex* H.L. Clark, 1939**
Figs 6.264 and 6.265.

Anophiura simplex Clark, H.L., 1939: 119, figs 55, 56; Clark, 1977: 135, 143.

Diagnosis *- adapted from Clark, H.L. (1939).*
D.D. up to 7mm, D.D./A.L. = 1/2. Disc round, covered in scales both dorsally and ventrally, primary rosette distinct. Dorsal interradial marginal area covered by single scale. Radial shields naked, large, broad triangular, one-third disc radius, as wide as long, contiguous but separated proximally by elongated scale. No arm combs. Oral papillae appear fused, with lowermost tooth distinct. Oral tentacle pores on outside of oral slit, with numerous scales surrounding pore. Oral shields naked, large, pentagonal, as wide as long, or slightly wider. Adoral shields large, contiguous. Genital slits long, thin, no genital papillae. Dorsal arm plates triangular, with slightly convex distal edge, small, as long as wide basally, becoming wider than long distally, not contiguous on entire arm. Ventral arm

plates small, twice as wide as long, elliptical, distal edge convex, not contiguous for entire arm. Lateral arm plates make up most of arm segments, meeting dorsally and ventrally. Arm spines three, very short, tapering, uppermost longest, first two separated from third spine. Tentacle pores not present on entire arm. Tentacle scales two or three basally, becoming single, circular.

Distribution and habitat

South Arabia (Clark, H.L., 1939), South Africa: off Kosi Bay (KZN); depth range: 720-1046m.
Habitat: No information available.

Remarks

Only one specimen was available for examination in the Iziko South African Museum collection. This species has three arm spines, in which two are separated from the third, similar to the spine arrangement in *Ophiura* (*Ophiuroglypha*) *irrorata irrorata.* The type material is in the Natural History Museum, London (NHMUK 1948.5.26.363) and the type locality is south Arabian coast, depth 1046m.

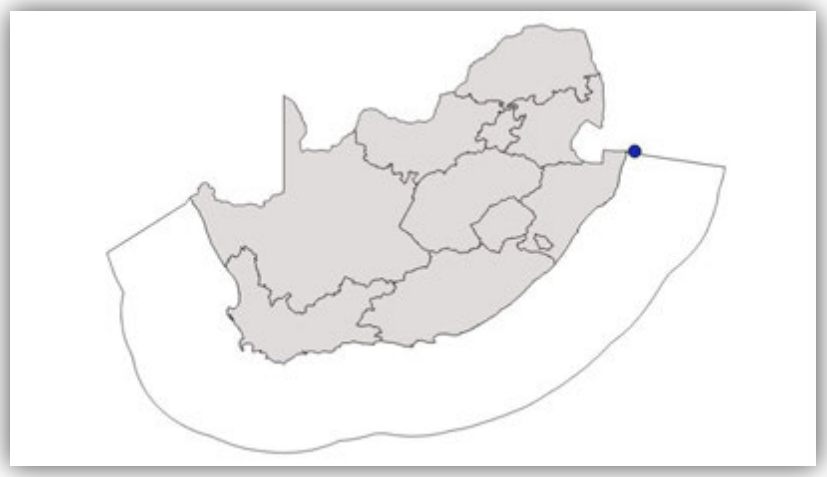

Figure 6.264. Distribution of *Anophiura simplex* in South Africa.

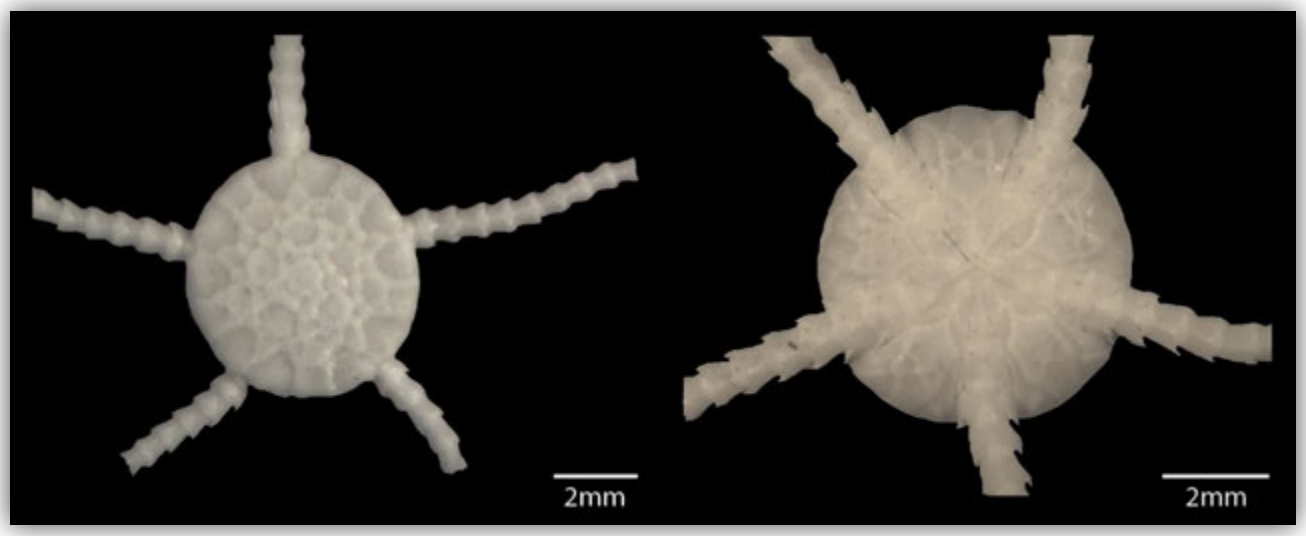

Figure 6.265. Dorsal (left) and ventral (right) views of *Anophiura simplex* (SAMC A22954).

Genus *Aspidophiura* Matsumoto, 1915

Diagnosis - *adapted from Matsumoto (1915).*
Disc elevated above arms, flat, covered with naked scales. Ventral interradial areas dominated by single plate. Arm combs present. Oral shields large. Oral papillae joined, second oral tentacle pores outside oral slits, with numerous scales. Genital slits two per interradius. Arms relatively short. Dorsal arm plates small or absent. Ventral arm plates small, triangular. Tentacle pores present only on first few basal segments. Arm spines three, short, conical. Tentacle scales present or absent.

Aspidophiura corone Hertz, 1927

Figs 6.266 and 6.267.

Aspidophiura corone Hertz, 1927a: 79-80, pl. 7, figs 1, 2; Clark, 1977: 135, 143.

Diagnosis - *adapted from Hertz (1927a) and Clark (1977).*
D.D. up to 5mm. Disc round with slight indentations at arm bases, covered in scales dorsally and ventrally, primary rosette distinct with large central plate. Dorsal interradial marginal area covered by large single scale. Radial shields naked, large, broad triangular, almost half disc radius, longer than wide, inner margins straight, not contiguous. Arm combs present. Oral papillae appear fused, lowermost tooth distinct. Oral tentacle pores lie outside of oral slit with numerous scales surrounding pore. Oral shields naked, large, spearhead-shaped with proximal tip triangular, sharp, lateral sides slightly restricted and distal edge with wide distal lobe. Adoral shields large, contiguous. Genital slits long, slightly restricted on lateral sides of oral shield. Dorsal arm plates triangular, very small, widely separated. Ventral arm plates small, fan-shaped, wider than long, distal edge convex, not contiguous for entire arm. Lateral arm plates make up most of arm segments, meeting dorsally and ventrally. Arm spines three, short, tapering. Tentacle pores large. Tentacle scales two basally, becoming single.

Distribution and habitat
Somalia and East Africa, South Africa: Cape Vidal (KZN) to Kosi Bay (KZN); depth range: 740-977m. Habitat: No information available.

Remarks
No new specimens have been found in South Africa since those identified by Clark (1977). The holotype (ZMB Ech 6984) is in the Museum of Natural History at the University of Berlin, type locality is off Somalia, East Africa, depth unknown.

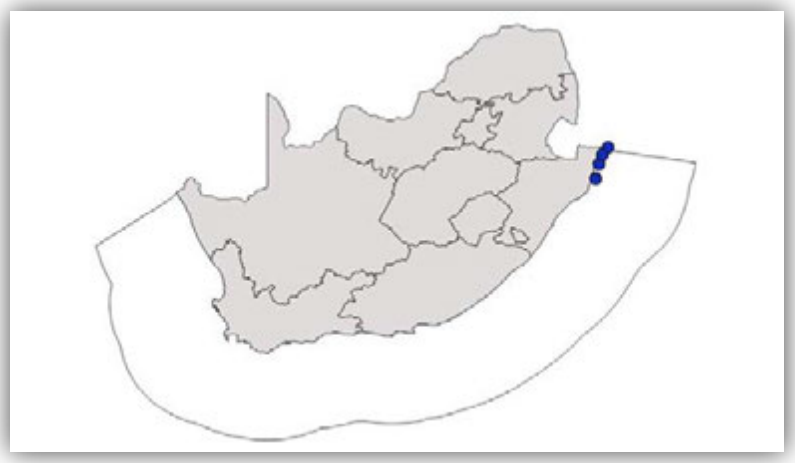

Figure 6.266. Distribution of *Aspidophiura corone* in South Africa.

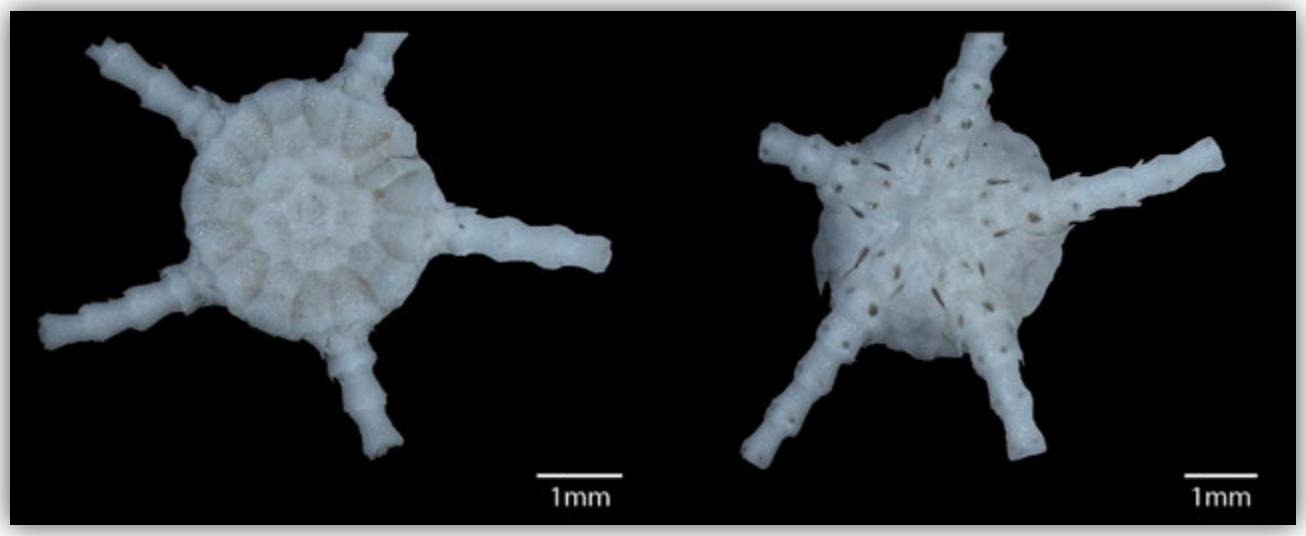

Figure 6.267. Dorsal (left) and ventral (right) views of *Aspidophiura corone* (SAMC A22955).

Genus Ophiolepis Müller and Troschel, 1840

Diagnosis *- adapted from Müller and Troschel (1840b) and Lyman (1882).*
Disc covered in thick scales surrounded by smaller scales, disc notched at each arm base. Teeth present, no dental papillae. Oral papillae numerous. Adoral shields wide, may or may not be contiguous. Genital slits two per interradius, thin, genital plates distinct. Supplementary dorsal arm plates present. Arm spines short, small.

Ophiolepis cincta cincta Müller and Troschel, 1842

Figs 6.268 and 6.269.

Ophiolepis cincta Müller and Troschel, 1842: 90; Lyman, 1865: 60; Lyman, 1882: 19, pl. 37, figs 7-9; Studer, 1882: 7; Koehler, 1905a: 16-17; Clark, 1915a: 342; Clark, 1921: 143; Mortensen, 1933c: 382-383; Balinsky, 1957: 28; Kalk, 1958: 207, 216, 238; Macnae and Kalk, 1969: 106, 130; Clark and Rowe, 1971: 90-91, 129, fig. 46c; Clark and Courtman-Stock, 1976: 107, 125, 189-190, fig. 196; Hughes and Gamble, 1977: 355; Cherbonnier and Guille, 1978: 232-234, fig. 74a-g; Guille and Vadon, 1985: 64; Marsh, 1986: 72; Vine, 1986: 195; Rowe and Gates, 1995: 434; Liao and Clark, 1995: 292-293, fig. 163, pl. 19, figs 4, 5; Mbongwa, 2013: 16.
Ophiolepis garretti Lyman, 1862: 77-78; Lyman, 1865: 61, pl. 2, fig. 4.
Ophioelegans cincta James, 1981: 15-17, pl. 1A.

Diagnosis *- adapted from Clark and Courtman-Stock (1976) and Cherbonnier and Guille (1978).*
D.D. up to 18mm. Disc pentagonal, covered dorsally and ventrally with smooth, imbricating scales, scales surrounded by smaller scales both dorsally and ventrally. Radial shields smooth, elongated, no larger than largest disc scales. Oral shields spearhead-shaped with distal lobe and rounded distal end, as long as wide. Adoral shields broad, contiguous. Oral papillae 3-4, broad, in series with oral tentacle scale. Teeth present, broad, rounded. Genital slits long, narrow, reaching edge of disc margin, genital plates distinct. Dorsal arm plates wider than long, supplementary smaller plates bordering lateral and distal edges of each dorsal arm plate. Ventral arm plates almost square basally, becoming strongly fan-shaped distally and narrowly contiguous. Arm spines 3-4 (usually three), short, conical, about half segment length. Tentacle scales two, oval, large. Colour in life, disc pink to brown, irregularly marbled with grey, white or silver patches, arms banded.

Distribution and habitat
Western Indian Ocean, Red Sea, Seychelles, China, south Japan, Philippines, Australia, Fiji (Clark and Rowe, 1971; Rowe and Gates, 1995), South Africa: Aliwal Shoal (KZN) to Bhanga Nek (KZN); depth range: 0-20m.
Habitat: Under boulders over sand and under coral debris.

Remarks
Easily recognisable by its pink, white and silver colouration. Type material is in the Museum of Natural History at the University of Berlin (syntype: ZMB Ech 863), type locality is the Red Sea, depth unknown.

Figure 6.268. Distribution of *Ophiolepis cincta cincta* in South Africa.

Figure 6.269. Dorsal (left) and ventral (right) views of *Ophiolepis cincta cincta* (RMCA MT2316).

Genus Ophiomusium **Lyman, 1869**

Diagnosis - *adapted from Lyman (1869).*
Disc covered by large, naked scales. Radial shields relatively large. Oral papillae fused, apical papillae present, teeth present. Genital slits two per interradius. Dorsal arm plates very small, not contiguous. Ventral arm plates present basally only. Lateral arm plates meeting above and below. Tentacle pores absent beyond basal arm segments. Arm spines small.

Ophiomusium lymani Wyville Thomson, 1873

Figs 6.270 and 6.271.

Ophiomusium lymani Wyville Thomson, 1873: 174-175, fig. 33; Koehler, 1904a: 58; Clark, 1911: 107-108; Clark, 1913: 213-214; Matsumoto, 1917: 289; Koehler, 1922b: 411, pl. 86, figs 5, 7-9; Clark, 1923: 364; Mortensen, 1927: 253-254, fig. 138; Mortensen, 1933c: 394; Clark and Courtman-Stock, 1976: 107, 125, 191, fig. 211; Baker, 1979: 30; Paterson, 1985: 147-148, fig. 58a, b; Alva and Vadon, 1989: 828; Imaoka *et al.*, 1990: 95; Garcia-Diez *et al.*, 2005: 49; Laguarda-Figueras *et al.*, 2009: 100, fig. 32.
Ophiomusa lymani: Hertz, 1927a: 103-105; Clark, H.L., 1939: 128.

Diagnosis *- adapted from Mortensen (1927).*
D.D. up to 48mm. Disc round, covered dorsally and ventrally with scales of various sizes, some tumid, others flat but with tubercles, cluster of flat scales in centre of disc, primary rosette sometimes distinct. Radial shields with embedded tubercles, triangular, longer than wide, *c.* half disc radius. Oral shields triangular, longer than wide, proximal lobe sharp, distal edge straight, bordered distally by pentagonal plate covering most of interradial area. Adoral shields broad and large, contiguous. Oral papillae 5-6 but almost appear fused, structure of each papilla still visible. Oral tentacle pore bordered by first arm plate. Genital slits half-way to disc margin, thin and narrow, genital plates present. Dorsal arm plates diamond or triangular, distal edge convex, widely separated, longer than wide, becoming smaller and entirely absent for much of the arm. Ventral arm plates only present on first three segments, pentagonal. Lateral arm plates meet dorsally and ventrally, very large. Arms slender but stiff. Arm spines up to 13, very small, conical. Tentacle scales one, oval, large, present on first two arm segments only.

Distribution and habitat
Arabian Sea, Indonesia, Australia, New Zealand, Chile, Gulf of Mexico, Caribbean and Atlantic Ocean (Baker, 1979; Rowe and Gates, 1995), South Africa: off Orange River (NC) to St Lucia (KZN); depth range: 130-4829m.
Habitat: Mud and sand.

Remarks
At first glance, this species is very similar to *Ophiomisidium* (Ophiuridae), but they differ in a number of characters. Species of *Ophiomusium* are much larger, have a larger number of dorsal disc plates and the ventral arm plates are rudimentary or absent. On the contrary, species of *Ophiomisidium* have an extremely reduced ventral interradial area and the genital slits are reduced or absent.

The distribution range is here extended westwards from off Saldanha Bay (WC) to off the Orange River (NC) and eastwards from off Cape Agulhas (WC) to St Lucia (KZN) (see Table 7.3).

According to Rowe and Gates (1995), the syntypes are most probably housed in the Natural History Museum, London, however these were not located. The type locality is off the coast of Ireland, depth unknown (Rowe and Gates, 1995).

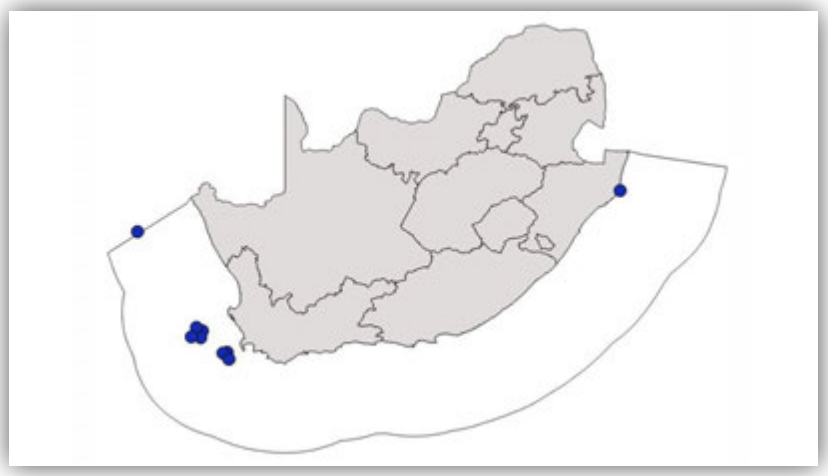

Figure 6.270. Distribution of *Ophiomusium lymani* in South Africa.

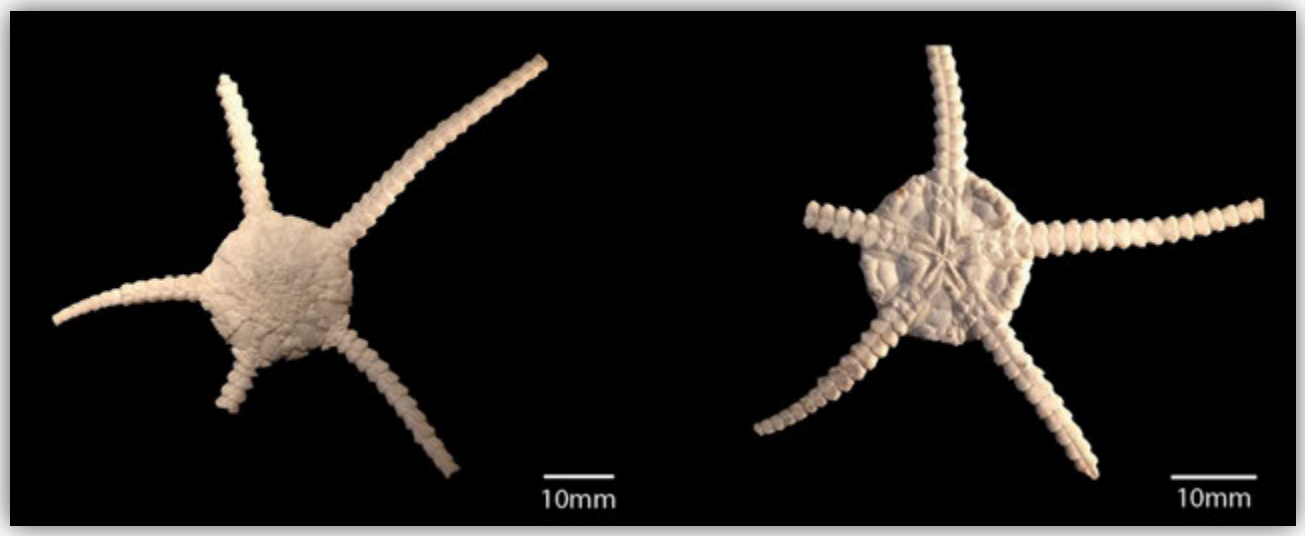

Figure 6.271. Dorsal (left) and ventral (right) views of *Ophiomusium lymani* (SAMC A22044).

Genus Ophioplocus **Lyman, 1862**

Diagnosis *- adapted from Lyman (1862) and Lyman (1882).*
Disc covered with close scales dorsally and ventrally. Teeth present. No dental papillae. Oral papillae present, closely set. Adoral shields wide, may or may not be contiguous. Genital slits two per interradius, short, extending only half-way to disc margin, genital plates indistinct. Dorsal arm plates fragmented. Arm spines three, stout.

Ophioplocus imbricatus **(Müller and Troschel, 1842)**
Figs 6.272 and 6.273.

Ophiolepis imbricata Müller and Troschel, 1842: 93-94.
Ophioplocus tessellatus: Lyman, 1862: 76-77; Lyman, 1882: 20.
Ophioplocus imbricatus: Lyman, 1865: 69-70; Lyman, 1882: 20, pl. 35, figs 10-12; Studer, 1882: 7; De Loriol, 1893a: 12-13; Bell, 1898: 849; Bell, 1909: 11; Clark, 1915a: 344; Clark, 1921: 143, pl. 12, fig. 8, pl. 35, figs 1-3; Koehler, 1922b: 435-436; Koehler, 1922a: 48, pl. 84, fig. 12; Clark, 1938: 365-366; Clark, 1946: 275-276; Clark and Rowe, 1971: 90-91, 128; Cherbonnier and Guille, 1978: 239-242, fig. 77a-f; Humpreys, 1981: 11; Guille and

Vadon, 1985: 64; Rowe, 1989: 287; Liao and Clark, 1995: 298-299, fig. 169; Putchakarn and Sonchaeng, 2004: 423; Stöhr *et al.*, 2008: 547, 553; Olbers *et al.*, 2015: 111-112, pl. 9C, D.
Ophioplocus imbricata: Rowe and Gates, 1995: 435.

Diagnosis *- adapted from Clark and Rowe (1971) and Cherbonnier and Guille (1978).*
D.D. up to 26mm. Disc round, disc scales slightly imbricated and distinct, with central plate present, scales naked. Radial shields small, elongated-oval, widely separated, naked. Genital slits small, short, quarter length of interradial area, genital papillae present. Oral shields triangular, moderately large, much wider than long, rounded angles, widest distally. Adoral shields relatively wide, may be contiguous or slightly separated. Jaws slightly sunken, 4-5 oral papillae, distalmost being broadest, remaining papillae elliptical leaf-shaped, apical papillae bluntly pointed. Teeth four, rounded. Oral tentacle scale inside oral slit. Dorsal arm plates fragmented along entire length of arm, with lateral arm plates becoming more prominent distally. Ventral arm plates slightly wider than long, rectangular and contiguous, becoming triangular and non-contiguous distally, distal edge rounded throughout. Arm spines three, stout, thick, conical, mostly appressed to arms, no longer than one segment length, becoming shorter distally, occasionally lowermost longest. Tentacle scales two, ovate or similar to spines in shape, rarely three. Colour in life dark green or grey with irregular patterns and patches on dorsal disc conforming to interradial areas, arms banded, ventrally brown but pale.

Distribution and habitat
Mozambique, Madagascar, Mascarene Basin, Reunion, Mauritius, Tanzania, Kenya, Aldabra, Somalia, Red Sea, Seychelles, Andaman Sea, Australia and New Zealand (Rowe and Gates, 1995; Putchakarn and Sonchaeng, 2004; Stöhr *et al.*, 2008; Stöhr *et al.*, 2016), South Africa: Sodwana Bay (KZN); depth range: 0-197m.
Habitat: Grey sand and mud, angiosperm beds, bases of coral or patch reefs.

Remarks
Olbers *et al.* (2015) recorded this species as a new record for South Africa. Syntypes (RMNH.ECH.857) deposited in Naturalis with the type locality as Indian Ocean (Joke Bleeker, pers. comm.) and *Ophiolepis imbricata* is in the Museum of Natural History at the University of Berlin (ZMB Ech 886), depth unknown.

Figure 6.272. Distribution of *Ophioplocus imbricatus* in South Africa.

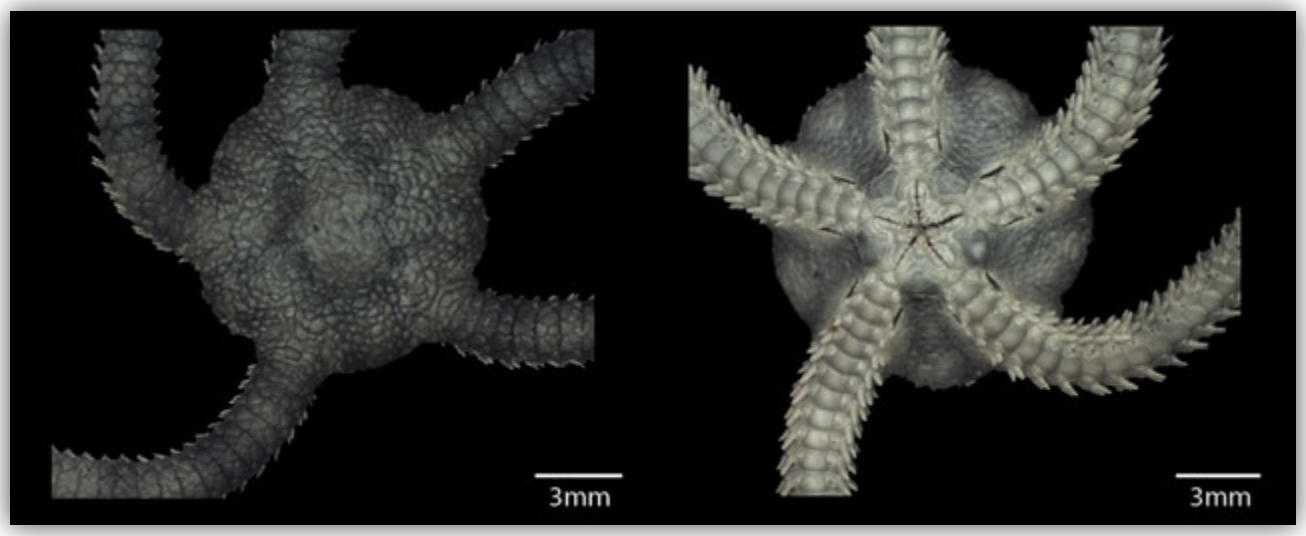

Figure 6.273. Dorsal (left) and ventral (right) views of *Ophioplocus imbricatus* (RMCA MT2306).

Chapter 7: Biogeography and biodiversity of South African brittle stars (Ophiuroidea: Echinodermata).

ABSTRACT

A total of 136 ophiuroid species are currently known from the Exclusive Economic Zone of mainland South Africa. These were collected or documented using six sampling methods: trawling, dredging, SCUBA diving, hand-collecting, photographic records and Remotely Operated Vehicles (ROV). Over time, trawling and dredging have become less popular sampling methods, with SCUBA diving becoming the most common modern collection method with photography increasing in popularity. Significant range extensions for 23 species are herein documented. It is established here that the number of species increased with depth until 100m, below which it declined steadily, with the deepest ophiuroid (*Ophiura* (*Ophiuroglypha*) *irrorata irrorata*) recorded at 3534m. Four families (Asteronychidae, Asteroschematidae, Euryalidae and Amphilepididae) were documented as exclusively offshore (>30m). The highest number of species was recorded on the east coast (109), while the south coast had the lowest number of species (45) and the west coast an intermediate number (55). The rate of change in diversity from west to east was calculated using beta-diversity which showed that the greatest rates of change occurred in known areas of biogeographical delineation. Peaks in the number of records and species generally coincided with major towns, cities, or other areas with easy access to the coast. Overall, 69 Indo-Pacific species make up the largest faunistic component, followed by 33 endemic, 18 species classified as 'other', 9 Atlantic and seven cosmopolitan species. Inshore, 42 Indo-Pacific species make up the largest faunistic component, while 13 endemic, four 'other', three cosmopolitan and two Atlantic species make up the remaining components. Offshore, the Indo-Pacific species make up the largest faunistic component, with 47 species, while the endemic (31) and 'other' (20) species followed, while the Atlantic and cosmopolitan components respectively made up of eight and seven species. Although a total of 33 (24.1%) species are endemic, there are no endemic genera or families. Distributional data from inshore (<30m) and offshore (>30m) are analysed separately. Inshore, 51.6% of species are known from five or less records, with 14.1% from a single record. The maximum number of records for a single species was 171. The inshore hosts 11 endemic species and the offshore 32. The highest numbers of endemic species occurs in the Natal (25) ecoregion, followed by Agulhas (19) and Southern Benguela (17) ecoregions, with the lowest number in the Southeast Atlantic (2) ecoregion. Offshore, 69.0% of species are known from five or less records and 4.4% from more than 50 records. The maximum number of records for a single species was 95.

INTRODUCTION

South Africa (excluding island territories) lies between latitudes 26°51'S and 34°50'S and has a continental coastline of 3650km and an Exclusive Economic Zone (EEZ) of 1 068 659km^2 (Griffiths *et al.*, 2010). The continental shelf is narrow on the east coast, intermediate on the west coast and extends *c.* 260km offshore to form the Agulhas Bank in the south. The greatest depth recorded within the continental EEZ is 5700m, with only 25% of the seafloor at depths shallower than 1000m (Griffiths *et al.*, 2010). South Africa is well-known for its extraordinary biodiversity and considered to be the third most biologically diverse country in the world (Van den Berg, 2008). The high biodiversity and biological spatial patterns are a product of the extensive variety of habitats and associated physical environments occurring within the region, which have been extensively documented (McQuaid and Branch, 1984; 1985; Shannon, 1985; Roel, 1987; Emanuel *et al.*, 1992; Bustamante and Branch, 1996; Bustamante *et al.*, 1997; Lutjeharms *et al.*, 2000; Sink, 2001; Connor *et al.*, 2004; Lombard *et al.*, 2004; Sink *et al.*, 2006; Connor *et al.*, 2006; Lombard *et al.*, 2007; McQuaid and Lindsay, 2007;

Yemane *et al.*, 2009; Blamey and Branch, 2009; Samaai *et al.*, 2010; Howell *et al.*, 2010; Harris *et al.*, 2011).

In 2010, it was estimated that 12 914 marine species had been reported from South African waters (Griffiths *et al.*, 2010), ~6% of the known global eukaryotic marine species (Appeltans *et al.*, 2012). This is a remarkable number for a mere 3650km of coastline (0.5% of the global coastline). South Africa is known to host 10% of the global fauna for most animal groups (Gibbons *et al.*, 1999; Acuña and Griffiths, 2004; Samaai, 2006; Thandar, 2015), despite the fact that a large number of regional species are still to be discovered, described and named. Approximately 31.4% of known South African marine species are thought to be endemic (Gibbons *et al.*, 1999; Griffiths *et al.*, 2010). This high biodiversity and endemism is a by-product of rapid changes in temperature, nutrient availability etc. effectively forming barriers around the coastline (Brown and Jarman, 1978; Bustamante and Branch, 1996; Tittensor *et al.*, 2010).

Marine biogeography of southern Africa

The earliest global marine biogeographical accounts were those of Forbes (1856), Woodward (1856), Ortmann (1896) and Ekman (1953), but it was only when Stephenson and Stephenson (1972) summarised 25 years of intertidal data which defined the three primary biogeographic regions around the South African coastline still widely accepted today. They are i) the cool-temperate west coast), ii) the warm-temperate south coast and iii) the subtropical east coast. In 2007, Spalding *et al.*, undertook a global marine biogeographic study in which they considered the South African coastline as falling into two realms, i) Temperate southern Africa (from southern Angola to an area in the vicinity of Cape Vidal), and ii) the Western Indo-Pacific Realm (from approximately Cape Vidal to Sumatra). However, within the Temperate southern Africa Realm, Spalding *et al.* (2007) suggested three inshore marine provinces which correspond closely to those of Stephenson and Stephenson, herein referred to as historic biogeographic regions, i.e., i) Benguela Marine Province (west), with the eastern boundary disputed to be somewhere between Cape Point and Cape Agulhas; ii) Agulhas Marine Province (South), with the northern boundary being somewhere between Cape Vidal and Sodwana Bay, and iii) Natal (East), extending from an area around Cape Vidal or Sodwana Bay, into southern Mozambique. Later, Briggs and Bowen (2012) proposed realigning the marine biogeographic provinces by eliminating the distinction between tropical and warm-temperate regions and between cold and cold-temperate regions by creating four global marine biogeographic provinces (cold, cold-temperate, warm temperate and warm). While they still recognise provinces within the warm-temperate and tropical zones, they intended demonstrating the evolutionary relationships of the living marine taxa, with the ultimate purpose of creating a framework for the establishment of smaller ecological units. Therefore, according to Briggs and Bowen (2012), the whole South African coastline should be referred to as a warm-temperate region in the global context.

Many publications have analysed inshore and coastal biogeography and the distribution of various marine taxa in southern Africa (Table 7.1), yet despite this, discussion on the numbers and exact locations of biogeographic breaks continue to be debated.

Lombard *et al.* (2004) and Sink *et al.* (2012) provide the most recent and comprehensive studies on marine biogeography of South Africa. They evaluated and analysed both biological and physical data, and together with extensive expert input, established a system of ecoregions and ecozones within South Africa. Lombard *et al.* (2004), proposed nine inshore and offshore bioregions. Later, Sink *et al.* (2012) refined and renamed the regions into six marine ecoregions and 22 marine ecozones. The inshore regions are based on detailed analyses of biological data, while the offshore regions are largely defined by surrogates or physical features, i.e. depth, temperature, substratum and current.

Table 7.1. Publications examining marine biogeographic patterns for various taxa in southern Africa.

Kingdom	Phylum / Class	Class / Order	Publication
Plantae	Algae		Hommersand, 1986; Bolton and Anderson, 1997; Bolton and Stegenga, 2002; Bolton *et al.*, 2004.
Animalia	Porifera		Samaai, 2006.
	Cnidaria	Actiniaria & Corallimorpharia	Acuña and Griffiths, 2004; Laird, 2013.
		Octocorallia	Williams, 1992.
		Hydroida	Millard, 1975.
	Polychaeta		Day, 1967a; Day, 1967b.
	Arthropoda	Arachnida	Procheş and Marshall, 2002.
		Cirripedia	Biccard, 2013.
		Isopoda	Kensley, 1978.
		Malacostraca	Barnard, 1950; Kensley, 1981.
		Euphausiacea	Gibbons *et al.*, 1995.
		Palinuridae	Cockcroft *et al.*, 2008.
	Echinodermata		Clark, 1923; Clark and Courtman-Stock, 1976; Thandar, 1989.
		Echinoidea	Filander, 2014.
		Holothuroidea	Thandar, 1984; Thandar, 2015.
	Ascidiacea		Monniot *et al.*, 2001; Primo and Vazquez, 2004.
	Vertebrata	Pisces	Turpie *et al.*, 2000; Harrison, 2002.
Combination of taxa			Stephenson, 1939; Stephenson and Stephenson, 1972; Brown and Jarman, 1978; McQuaid and Branch, 1984; Field and Griffiths, 1991; Emanuel *et al.*, 1992; Bustamante and Branch, 1996; Gibbons *et al.*, 1999; Awad *et al.*, 2002; Franschetti *et al.*, 2005; Sink *et al.*, 2005; Porter, 2009; Scott, 2009; Griffiths *et al.*, 2010.

Regional echinoderm diversity

Available zoogeographic and species richness information for echinoderms in the region are presented in Table 7.2. A number of authors have undertaken studies, but their areas of study have differed slightly. Clark and Courtman-Stock (1976) and Thandar (1989) included data on echinoderms in southern Africa, while the studies by Griffiths *et al.* (2010) and Filander (2014) only included data within the political boundaries of South Africa. Thandar (1989; 2015) synthesised the zoogeographic knowledge available up to that time on the echinoderms in southern Africa. He analysed the distribution of 407 echinoderm species, later revising this to 463 species in 2015. Griffiths *et al.* (2010) recorded 410 echinoderm species for South Africa. Currently, 486 echinoderm species are known from South Africa alone.

Table 7.2. Available data on species richness and biogeographic affinities of five classes of echinoderm within southern and South Africa. The numbers of species are given, with percentage contribution of each class in brackets.

	Echinodermata	Asteroidea	Crinoidea	Echinoidea	Holothuroidea	Ophiuroidea
Clark and Courtman-Stock (1976) Study Area: Southern Africa						
Total number		92 (32.3%)	19 (6.6%)	59 (20.7%)	-	115 (40.4%)
Thandar (1989) Study Area: Southern Africa						
Total	407	99 (24.3%)	17 (4.2%)	59 (14.5%)	108 (26.5%)	124 (30.5%)
Atlantic	26 (6.4%)	10 (10.1%)	1 (5.9%)	3 (5.1%)	4 (3.7%)	8 (6.5%)
Cosmopolitan	12 (2.9%)	1 (1.0%)	0	1(1.7%)	5 (4.6%)	5 (4.0%)
Indo-Pacific	151 (37.1%)	21 (21.2%)	7 (41.1%)	31 (52.5%)	45 (41.7%)	47 (37.9%)
Other	28 (6.9%)	10 (10.1%)	1 (5.9%)	1 (1.7%)	9 (8.3%)	7 (5.6%)
Endemic	190 (46.7%)	57 (57.6%)	8 (47.1%)	23 (39.0%)	45 (41.7%)	57 (46.0%)
Griffiths *et al.* (2010) Study Area: South Africa						
Total	410	91 (22.2%)	19 (4.6%)	59 (14.4%)	122 (29.8%)	119 (29.0%)
Endemic	15 (3.7%)	55 (60.4%)	9 (47.4%)	25 (42.4%)	46 (37.7%)	52 (43.7%)
Filander (2014) Study Area: South Africa						
Total	-	-	-	71	-	-
Endemic				19 (26.7%)		
Thandar (2015) Study Area: Southern Africa (shelf (<200m) species only)						
Total	306	-	-	-	117 (38.2%)	-
Atlantic	18 (6.0%)	-	-	-	1 (1.0%)	-
Cosmopolitan	2 (0.8%)	-	-	-	0	-
Indo-Pacific	134 (43.6%)	-	-	-	42 (35.9%)	-
Other	15 (4.9%)	-	-	-	14 (11.9%)	-
Endemic	137 (44.7%)	-	-	-	60 (51.2%)	-
Erich Koch, pers. comm. Study Area: South Africa						
Total	-	116	-	-	-	-
Ahmed Thandar, pers. comm. Study Area: South Africa						
Total	-	-	-	-	143	-

Thandar (1989) found that most of the classes were dominated by Indo-Pacific species, while the greatest endemic component (to the wider southern African region) occurred within the Asteroidea, followed by the Crinoidea, Ophiuroidea and Holothuroidea. The Echinoidea had the smallest portion of endemics (39.0%). Filander (2014) showed that only 26.7% of the Echinoidea were endemic to South Africa itself. Griffiths *et al.* (2010) revised the echinoderm endemism values, finding the same pattern as Thandar (1989), the class with the highest endemism being the Asteroidea, followed by the Crinoidea and Ophiuroidea. However, the Holothuroidea had the lowest endemism (Griffiths *et al.*, 2010) and not the Echinoidea, as suggested by Thandar (1989). Griffiths *et al.* (2010) stated that the echinoderms are one of the few well-documented marine taxa in South Africa. Currently, the taxonomy and biogeography of the Asteroidea (sea stars) is currently in progress, that of the Ophiuroidea (brittle stars) is presented herein, while that of the Echinoidea (Urchins and Sand Dollars) (Filander, 2014; Filander and Griffiths, 2014) and Holothuroidea (sea cucumbers) (Thandar, 2015) are complete and recently published. Crinoidea taxonomy and biogeography remain severely out of date and this group is urgently in need of revision.

The Ophiuroidea (brittle stars, basket stars and snake stars) are a large and diverse group of extant Echinoderms (Stöhr *et al.*, 2012) with 2136 described species globally (Stöhr *et al.*, 2016), occurring at all depths. Although the study areas were slightly different, Griffiths *et al.* (2010) stated that for South Africa, there were 119 Ophiuroidea known, with 43.7% endemism, while Thandar (1989) suggested for southern Africa there were 124 Ophiuroidea known with 46% endemism (Table 7.2). Most of the Ophiuroidea species have an Indo-Pacific affinity (37.9%), followed by species with an Atlantic affinity (6.5%). Olbers *et al.* (2015) added 24 new species to the South African Ophiuroidea fauna, elevating the total to 136 species. Even though Ophiuroidea distribution and depth ranges have been mentioned in a variety of publications (Clark, 1923; Mortensen, 1925; Mortensen, 1933c; Clark, A.M., 1952; Clark, 1974; Clark and Courtman-Stock, 1976; Clark, 1977; Olbers and Samyn, 2012; Okanishi *et al.*, 2013; Olbers *et al.*, 2014; Olbers *et al.*, 2015), as a result of the additional species, new distribution range extensions and new depth records, a revised consolidated biogeographical account is now required. This chapter aims to document the history of sampling methods, and analyse distributions, depth patterns, species richness, faunistic affinities, endemicity and diversity patterns for the South African Ophiuroidea.

MATERIALS AND METHODS

Study area, data availability and dataset consolidation

The study area was limited to the EEZ of mainland South Africa (Figure 7.1). The data within the study area were divided into two datasets, the inshore, being defined as the area between the shoreline and 30m depth and the offshore (>30m). The inshore was further subdivided into a series of 30 x 100km sections from west to east, following Bolton and Stegenga (2002). It should be noted here that the last section (section 30) is less than 100km in length, but was still treated equally in the analysis. The offshore (>30m) dataset, the area was divided into spatial quarter degree grid cells (QDGC). Each 100km section and each QDGC was treated as a sampling unit within the respective datasets.

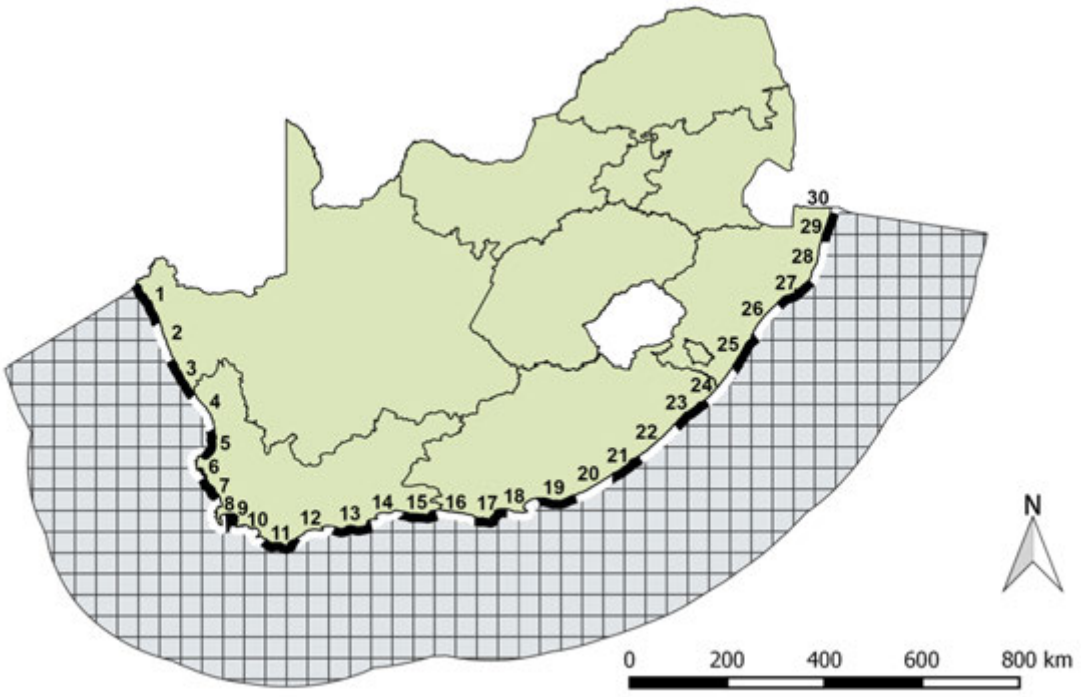

Figure 7.1. Exclusive Economic Zone (EEZ) of mainland South Africa showing the thirty inshore sections (100km each; see Bolton and Stegenga, 2002) and quarter degree grid cells (QDGC) used for biogeographic analyses.

Only valid species, according to published literature, are included. Three species were excluded from the spatial analyses, *Astrocladus africanus* Mortensen, 1933c, *Ophiogymna capensis* (Lütken, 1869) and *Ophionereis vivipara* Mortensen, 1933c, because no depth or locality data were available. However, they were included in the faunistic analysis, as they are known to occur in South Africa.

All records were consolidated into a relational database showing species name, taxonomic affiliation, accession number, locality, depth, date of collection, collection method, determinant, source of record, etc. All records with locality data were used when plotting distribution patterns, regardless of whether depth data were available or not. In cases where available localities were broad, such as 'off Durban, 100m', a point locality was created at the appropriate depth using GIS software. In addition, a presence / absence matrix for all species in both inshore and offshore datasets were created for the multivariate analysis. Occurrence data were interpolated, i.e. continuous occurrence between two localities was assumed. For the purposes of the diversity analyses, occurrence data were also interpolated as recommended by Van den Hoek and Donze (1967), Van den Hoek (1975), Emanuel *et al.* (1992), Awad *et al.* (2002), Bolton and Stegenga (2002), Procheş and Marshall (2002) and Bolton *et al.* (2004).

Sampling and sampling methods over time

In order to identify whether sampling methods and intensity had changed over time, records where collection date and sampling gear information were available were extracted and analysed. Six types of sampling were identified: trawling, dredging, SCUBA diving, hand-collecting, photographic records and Remotely Operated Vehicle (ROV) samples. Temporal trends in the prevalence of each sampling method were plotted, with SCUBA diving and hand-collecting being combined as a single method. Due to the small number of ROV samples, they were not included in the plot.

Distribution range

The distribution ranges of all species were revised and those with new or extended ranges were tabulated to show historical and new ranges and direction of range expansion. These updated data were then used in the analyses.

Depth Analysis

Each species was allocated a minimum and maximum depth limit, based on available data. In addition, each record where depth data were available, was assigned to one or more of the following depth categories: 0-30m (inshore), 31-500m (shelf & slope), 501-3500m (bathyal) or 3501m+ (abyssal). Records from the intertidal and shore were assigned a depth of 0m. The epizoic species *Ophiocnemis marmorata* (Lamarck, 1816), in which specimens were washed up on the beach together with their host jellyfish, were assigned a depth of 0m. The change in number of species with increasing depth was also documented.

Patterns of biodiversity and biogeography

These results are presented in three categories, i) the broad patterns of the data within the whole study area, ii) inshore data, which includes all records from the shore to 30m depth, and iii) the offshore data, beyond 31m depth.

Species richness

The number of species (and associated records) were analysed for the full dataset (broad patterns), inshore dataset, offshore dataset and the biogeographic areas.

Faunistic affinities and endemism

Each record was assigned to one of five faunistic categories, based on its global distribution. Categories were Atlantic, cosmopolitan, endemic, Indo-Pacific and 'other'. The category 'other' were those species found in the Atlantic and non-tropical parts of the Indian Ocean, but which are not endemic or cosmopolitan, and / or occur in the Southern Ocean, but not in the Pacific Ocean, North Atlantic and / or Mediterranean. The Atlantic component comprises those species found in whole or parts of the tropical / temperate Atlantic Ocean. Cosmopolitan species were those recorded in the tropics, subtropics, northern and southern cold-temperate and warm-temperate zones of all oceans and polar species. Endemic species are those only found within the political boundaries of South Africa. Indo-Pacific species included those found in the tropical Indian Ocean and the western and central Pacific Ocean.

Spatial patterns and diversity

All data were subjected to classification analyses based on link-average groupings using Bray-Curtis similarity index and ordination with multi-dimensional scaling (MDS) in PRIMER 6 (Plymouth Routines In Multivariate Ecological Research). A similarity profile (SIMPROF) was undertaken to determine which species indicated similarity within and between groups, based on their presence / absence. An analysis of similarities (ANOSIM) were also conducted to test for significance within and between ecoregions (Southern Benguela, Southeast Atlantic, Agulhas, Southwest Indian, Natal and Delagoa; as defined by Sink *et al.*, 2012), historic biogeographical regions (West, South and East; as defined by Stephenson and Stephenson, 1972) and the five faunistic categories, defined above. In the ANOSIM, the test statistic (R) reflects the observed differences between groups, compared with differences within groups. The R-statistic is most often between 0 and 1, with R = 1 indicating all regions / categories / clusters within a group are more similar to each other than regions / categories / clusters from different groups, or if R = 0, then the similarities between and within groups are, on average, the same (Clarke and Warwick, 1994). On the MDS plots, the Kruskal stress is indicated, which is a measure of the distance between points in an MDS matrix, therefore the smaller the stress, the better the representation (Clarke and Warwick, 1994). These analyses were performed separately on both inshore and offshore datasets to compare the variation in species composition in each dataset and sampling units. The presence / absence matrix was not transformed or standardised, as recommended for presence / absence datasets (Clarke and Warwick, 1994). All spatial data were plotted and analysed in QGIS, Primer, SigmaPlot and Excel software.

In an effort to measure where the greatest species turnover, or rate of change in species composition, occurs, ß-diversity was measured along the coastline and from west to east within the EEZ. To do this, the presence / absence datasets were interpolated. For the inshore component, if a species was recorded in Cape Town and in Durban, then it is assumed that it also occurred between these two points. The same procedure was followed for the offshore component where species data were grouped in QDGC transects perpendicular to the coastline to the boundary of the EEZ, so that each transect included the same length of coastline and they were all more of less the same length from coastline to edge of EEZ. (Figure 7.1). This is a standard and recommended procedure for the following type of analysis (Van den Hoek and Donze, 1967; Van den Hoek, 1975; Emanuel *et al.*, 1992, Awad *et al.*, 2002; Bolton and Stegenga, 2002, Procheş and Marshall, 2002 and Bolton *et al.*, 2004). The ß-diversity ($ß_T$) was calculated as a measure of species turnover between coastal sections and QDGC transects using the index of Wilson and Shmida (1984):

$$\beta T = \frac{g(H) + l(H)}{2 \propto}$$

Where: *g(H)* equals the species gained between sections or columns, *l(H)* equals species lost between sections or columns and $\propto$ is the average species richness of the coastal sections or QDGC transects.

RESULTS

Study area, data availability and dataset consolidation

A total of 2266 data points (955 inshore; 1311 offshore) were used in the analyses, 1478 of these data points were newly added as a result of this study. Included in the data were 136 species, 24 of which were reported in this analysis as new to South Africa (Olbers *et al.*, 2015). A total of 60 genera were present, 34 of which were represented by a single species, 12 by two species, four by three species, four by four species, one by five species, two by seven species, one by eight species, one by nine species and one by 12 species. The genus with the largest number of species (12) was *Amphiura*, followed by *Ophiura* (nine species).

A total of 15 families were present, with a mean of 9.1 (SD = 7.05) species per family. The family with the highest number of species was the Amphiuridae, with 22, followed by the Ophiuridae with 20 and the Ophiotrichidae and Ophiacanthidae, both with 16. Two families were represented by a single species, two by two species each, two by four species each, one by six species, two by nine species and one by 12 species and one by 13 species (see Appendix B for full species list for South Africa).

Sampling and sampling methods over time

Olbers *et al.* (2015) suggested that the first ophiuroid record reported for South Africa was that by Retzius (1783) with additional reports before the *Challenger* expedition by Müller and Troschel (1842) and Ljungman (1867b). Over time, more records became available, mostly offshore, as a result of a number of historical expeditions, such as the *Challenger*, *Pieter Faure*, *Meiring Naude*, South Africa Fisheries surveys, *Pickle, UCT Ecological Survey, Africana, Anton Bruun, Safari, Natal Museum Dredging Programme* and the *Valdivia.*

For the purposes of this study, pre-1976 data are referred to as historical, i.e. data which were included in the Clark and Courtman-Stock monograph. A total of 1994 records had collection dates available, of these, 1290 (64%) were collected before 1976 and 704 (36%) since 1976. Figure 7.2 compares the numbers of records obtained by different sampling methods per decade from 1870 to 2013. In the data, there are 1387 records where collection methods are known. Dredged Ophiuroidea samples from the *Challenger* were the first records for South Africa. Since then, dredging and trawling were the main methods of obtaining samples until the 1930's, when hand samples from the shore were first collected. Dredging and trawling effort were at their peaks in the 1950's and 1960's. Dredging and trawling began to taper off from the 1970's and continued to do so during the 2010's. The first record of an ophiuroid being obtained by SCUBA in South Africa is in 1967, during a JLB Smith Institute field trip to northern KZN. SCUBA and hand-collections appeared to be erratic, with a dramatic slump in the 1980's but a peak in the 1990's, but the overall trend is increasing over time. The increase in records in the 1990's coincide with the three Belgian echinoderm expeditions which took place in KZN.

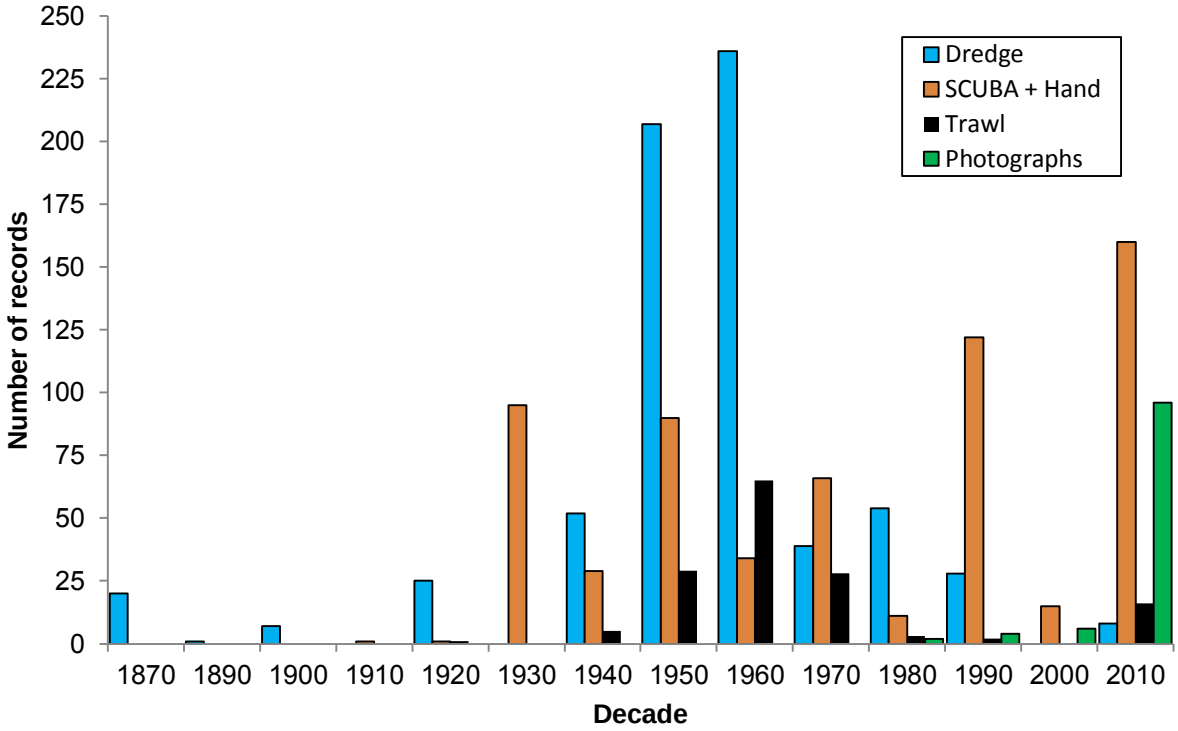

Figure 7.2. Time series showing different methods of collection of Ophiuroidea samples in South Africa per decade from 1870 to 2013.

Of the samples analysed above, 688 were from the inshore and 699 from the offshore. In the inshore, 132 records were collected by dredging and trawling, with the remaining 556 collected by hand or by SCUBA diving. Of the 699 offshore records, only 8 were obtained by SCUBA diving. Dredging and trawling were minimal in the Southeast Atlantic (2.4%), Southwest Indian (2.6%) and Delagoa (5.2%) ecoregions but high in the Agulhas (35.4%), Natal (24.9%) and Southern Benguela (29.5%) ecoregions.

Although only six ROV records were present in the dataset, there were 108 photographic records, mostly from EchinoMAP and iSpot. With the increasing popularity of citizen science, EchinoMAP and iSpot, both launched in 2012, are two of many platforms via which environmental enthusiasts are able to load data and contribute distribution records of various fauna and flora. As a result, there has been an increase in the use of photographic records for Ophiuroidea since the 1980's, with the highest number (26) being recorded in 2013.

Distribution range

New data collected during this study resulted in significant range extensions for 23 species previously reported from South Africa and these are listed in Table 7.3. Ten species demonstrated both an easterly and westerly extensions, while eight extended east only and five west only. The greatest range extensions were those of *Astrodendrum capensis* (~2565km) and *Ophiomusium lymani* (~2237km), both of which were expanded in both easterly and westerly directions. The greatest eastern extension was that of *Ophiomisidium pulchellum* (~1610km), while the greatest westerly extension was by *Ophiocoma pica* (~593km). Of the 23 species with extended ranges, eight were Indo-Pacific species, seven endemic, five categorised as 'other' (see above), with a single species in each of the Atlantic and cosmopolitan categories.

Depth analysis

The depth analysis was undertaken on 2298 data records for which this information was available, including 134 species. *Astrocladus africanus* Mortensen, 1933c, *Ophiogymna capensis* (Lütken, 1869) and *Ophionereis vivipara* Mortensen, 1933c were excluded due to no depth data being available. The depths at which the specimens were collected ranged from 0-3534m.

The greatest number of records were found on the shelf & slope (1162) and in the inshore (951) followed by the bathyal zone (184), with only a single record (*Ophiura* (*Ophiuroglypha*) *irrorata irrorata*) recorded in the abyssal category.

Figure 7.3 illustrates the depth distribution of 134 species and 15 families occurring in South Africa. There were four exclusively offshore or deep-water (>30m) families recorded, namely, Asteronychidae, Asteroschematidae, Euryalidae and Amphilepididae. The family Ophiocomidae is known to be mostly a shallow-water or inshore (0-30m) family, but in South African waters, Ophiocomidae are found in the inshore (0-30m) and on the shelf & slope (31-500m). Other families found on both the inshore and shelf & slope are the Ophionereididae, Ophiotrichidae and Ophiodermatidae. Families occurring in three depth ranges included Gorgonocephalidae, Ophiuridae, Amphiuridae, Ophiactidae, Ophiacanthidae and Ophiolepididae.

Table 7.3. Historical and updated distribution ranges of Ophiuroidea species with range changes within South Africa. Historical ranges were generated from Clark and Courtman-Stock (1976).Total range extensions are given, together with direction. Where extensions were in both directions; these are given with distances and direction separately. Provinces of towns in brackets: NC: Northern Cape; WC: Western Cape, EC: Eastern Cape and KZN: KwaZulu-Natal. *Clark and Courtman-Stock (1976) doubted if the record at Bhanga Nek / Mozambique was valid.

Species	Extension & direction	Historical Range within South Africa	New range within South Africa
Gorgonocephalidae			
Astrodendrum capensis	2565km: 2392km SW, NW; 173km NE	Durban (KZN) to Amatikulu (KZN)	South of Orange River (NC) to Leven Point (KZN)
Gorgonocephalus chilensis	1257km NE	Cape Town (WC)	Cape Town (WC) to Glenmore (KZN)
Ophiuridae			
Ophiomisidium pulchellum	1610km NE	Cape Point (WC) to Knysna (WC)	Cape Point (WC) to Amanzimtoti (KZN)
Ophiura kinbergi	221km NE	Durban (KZN) to Amatikulu (KZN)	Durban (KZN) to Sodwana Bay (KZN)
Ophiura trimeni	460km NE	Platbaai (NC) to Zotsha River (KZN)	Platbaai (NC) to Sodwana Bay (KZN)
Amphiuridae			
Amphipholis similis	223km NE	Gouritz (WC) to Amatikulu (KZN)	Gouritz (WC) to Sodwana Bay (KZN)
Amphiura (*Amphiura*) *acutisquama*	2039km: 183km NW; 1856km NE	Deurspring (WC) to Mauritzbaai (WC)	Zout River (NC) to Tinley Manor (KZN)
A. (*Amphiura*) *albella*	509km NE	Portobello Beach (KZN) to Amatikulu (KZN)	Portobello Beach (KZN) to Island Rock (KZN)
A. (*Amphiura*) *atlantica*	651km: 20km NW; 631km NE	Strandfontein (NC) to Kleinmond River (EC)	Galjoen Bay (NC) to Durban (KZN)
A. (*Amphiura*) *capensis**	307km NE	Orange River (NC) to Amatikulu (KZN)	Orange River (NC) to Kosi Bay (KZN)
A. (*Amphiura*) *grandisquama natalensis*	271km NE	Durban (KZN) to Amatikulu (KZN)	Durban (KZN) to Black Rock (KZN)
A. (*Amphiura*) *incana*	90km: 7km NW; 83km NE	Deurspring (WC) to Durban (KZN)	Lamberts Bay (WC) to Tugela River (KZN)
Ophiodaphne scripta	62km SW	Bhanga Nek (KZN) to Kosi Bay (KZN)	Sodwana Bay (KZN) to Kosi Bay (KZN)
Ophiocomidae			
Ophiocoma erinaceus	417km SW	Bhanga Nek (KZN) to Kosi Bay (KZN)	Treasure Beach (KZN) to Kosi Bay (KZN)
O. pica	593km SW	Richards Bay (KZN) to Kosi Bay (KZN)	Qolora (EC) to Kosi Bay (KZN)
O. scolopendrina	128km SW	Portobello Beach (KZN) to Kosi Bay (KZN)	Umgazana (EC) to Kosi Bay (KZN)
Ophionereididae			
Ophionereis dubia dubia	312km: 25km NW; 287km NE	Cape Town (WC) to Amatikulu (KZN)	Elands Bay (WC) to Bhanga Nek (KZN)
Ophiacanthidae			
Ophiacantha nerthepsila	375km: 108km NW; 267km NE	Saldanha Bay (WC) to Xora River (EC)	Cape Town (WC) to Mfafazana (KZN)
O. scutigera	207km: 176km NE; 31km SW	Durban (KZN) to Amatikulu (KZN)	Amanzimtoti (KZN) to Leven Point (KZN)
Ophiomitrella corynephora	1000km: 167km NW; 833km NE	Frederik se Baai (NC) to Jefferys Bay (EC)	Orange River (NC) to Clansthal (KZN)
Ophiodermatidae			
Ophiarachnella capensis	417km:108km NW; 309km NE	Cape Town (WC) to Amatikulu (KZN)	Langebaan (WC) to Kosi Bay (KZN)
Ophiopeza fallax fallax	54km SW	Durban (KZN) to Bhanga Nek (KZN)	Aliwal Shoal (KZN) to Bhanga Nek (KZN)
Ophiolepididae			
Ophiomusium lymani	2237km: 574km NW; 1663km NE	Saldanha Bay (WC) to Cape Agulhas (WC)	Orange River (NC) to St Lucia (KZN)

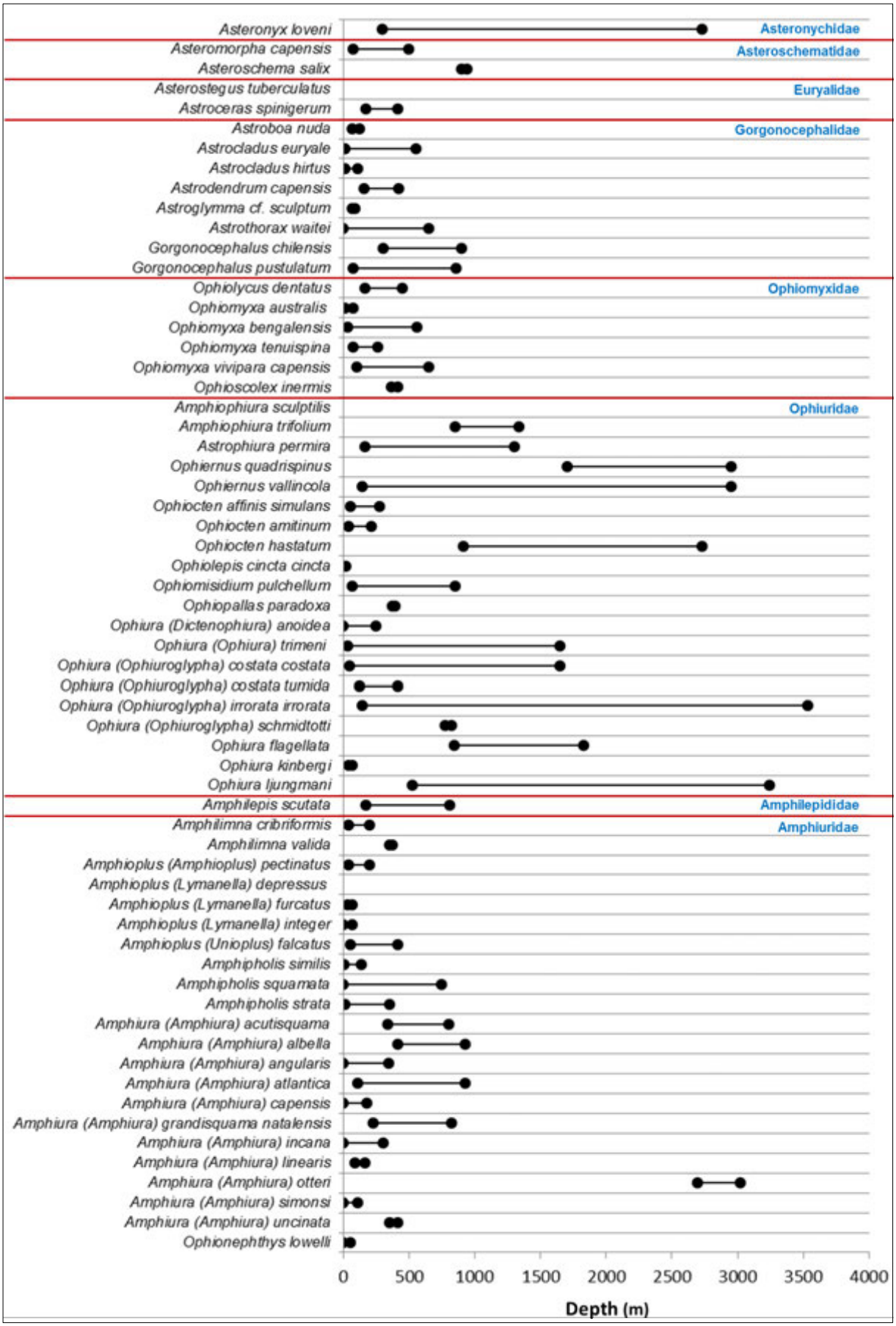

Figure 7.3. Depth ranges for South African Ophiuroidea within 15 families. Species on the *y*-axis are arranged alphabetically according to family. Families are separated by red lines.

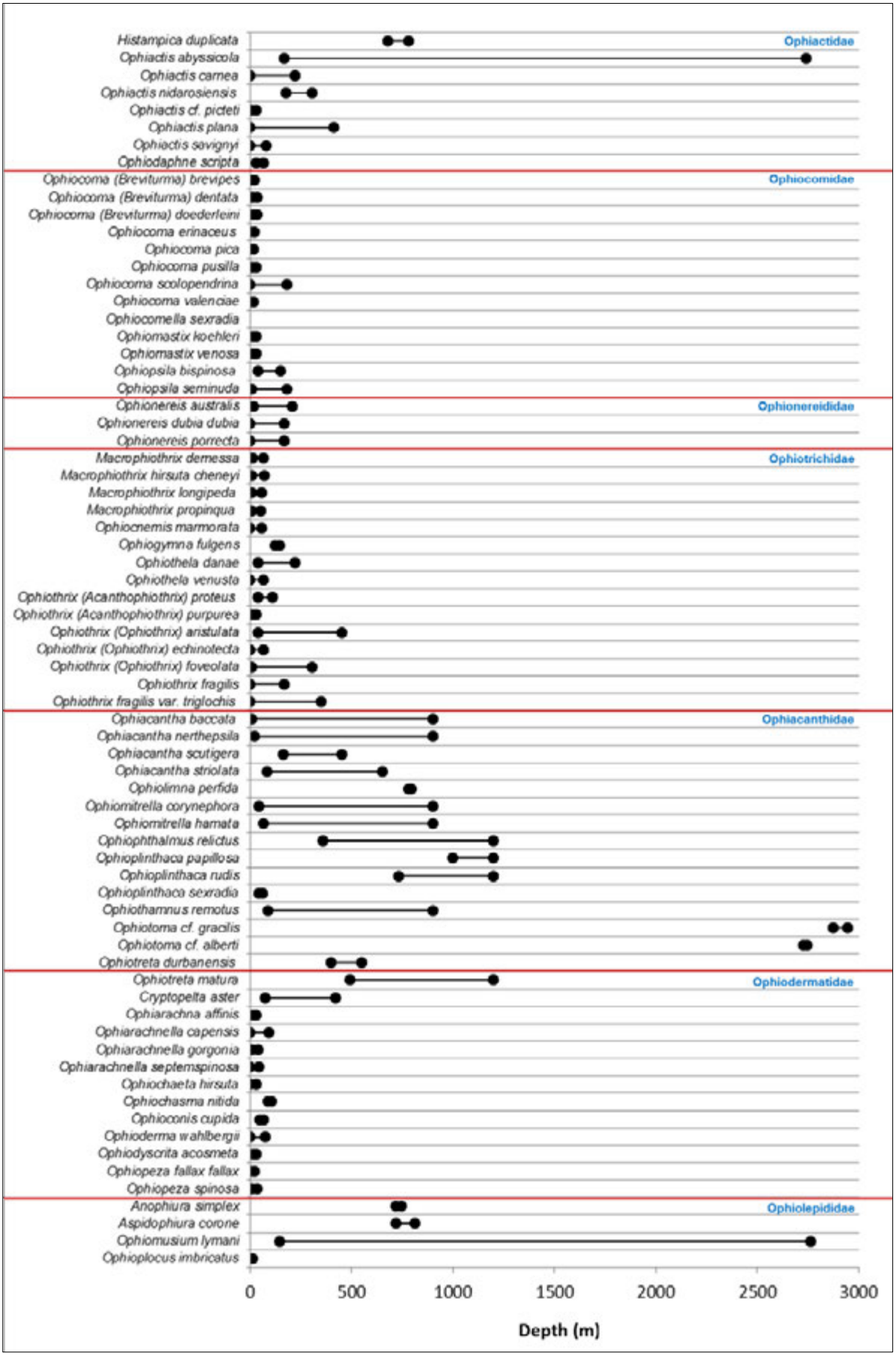

Figure 7.3 continued. Depth ranges for South African Ophiuroidea within 15 families. Species on the *y*-axis are arranged alphabetically according to family. Families are separated by red lines.

The greatest depth ranges were demonstrated by *Ophiura (Ophiuroglypha) irrorata irrorata* (3534m) and *Ophiernus vallincola* (2948m). Thirty-two species were recorded at 0m. *Ophiocomella sexradia*, although has a depth range of 0-33m, it has only been found in South Africa at 0m on rocky shores in KwaZulu-Natal. *Ophiocnemis marmorata*, although found alive in host jellyfish at 0m on the shore, have also been recorded at 57m.

Figure 7.4 shows the change in number of species found with increasing depth. Initially there is an increasing number of species from 0-100m, then the number of species declined with increasing depth.

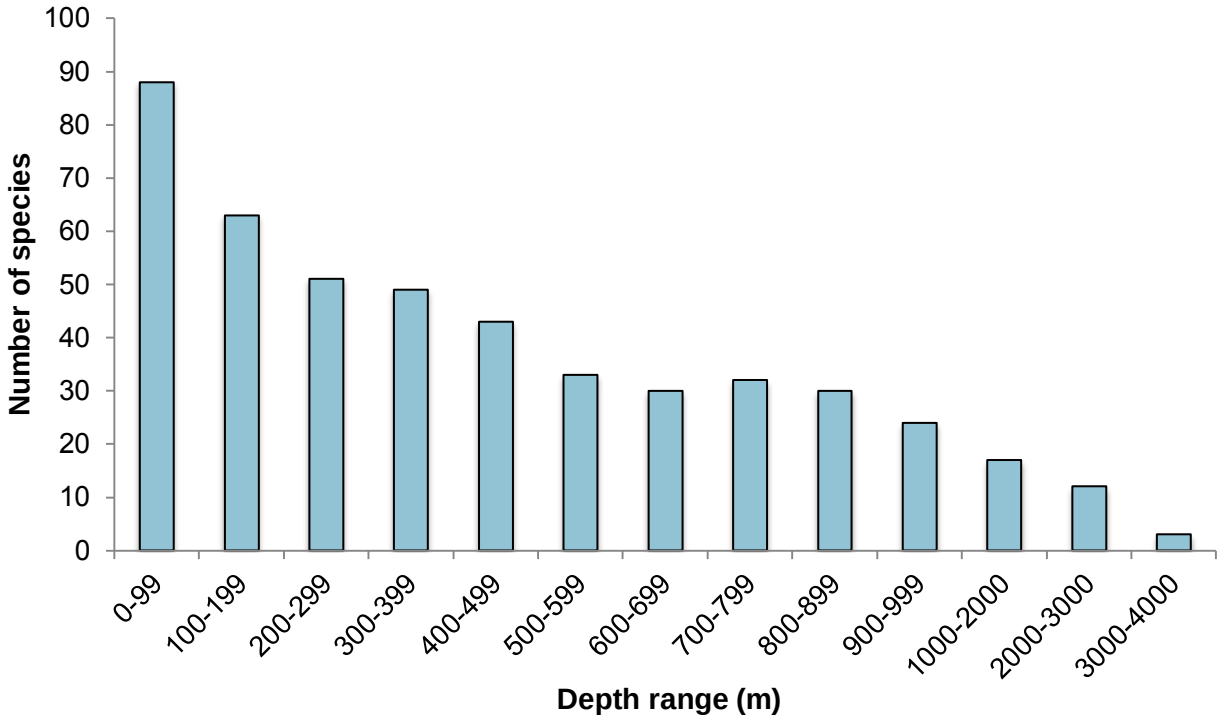

Figure 7.4. Number of species of South African Ophiuroidea found within each depth range.

Patterns of biodiversity and biogeography

i) Broad Patterns

Species richness

Species richness in each of the historic biogeographic regions, using both inshore and offshore data combined, is shown in Figure 7.5. The highest number of species was recorded on the east coast (109), while the south coast had the lowest species richness (45) and the west coast an intermediate number (55). This is not correlated with the number of records, which was highest for the west coast (1097) followed by the east coast (750) and lowest on the south coast (424). Incorporating the bias caused by numbers of samples taken, the data are thus indicative of an increasing trend in species richness from west to east within the study area.

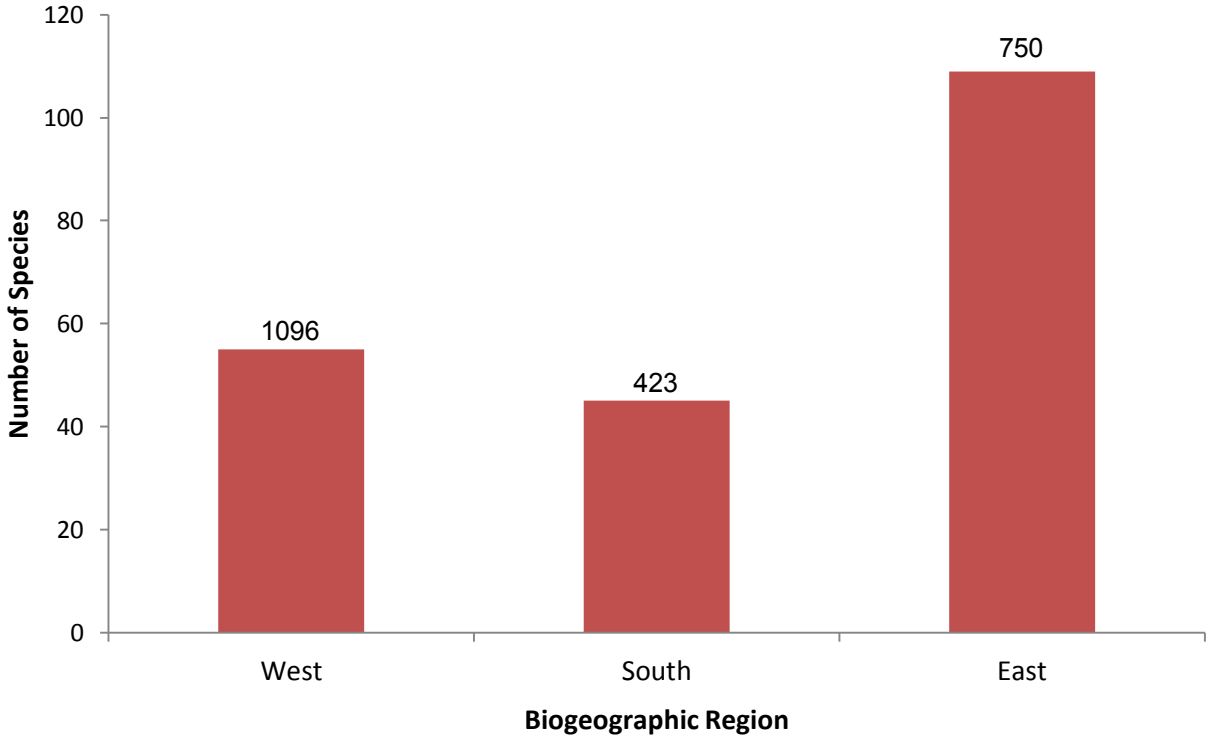

Figure 7.5. The number of species of South African Ophiuroidea in each of the three historic biogeographic regions as defined by Stephenson and Stephenson (1972). Number of records indicated on each bar.

Species richness and number of records across the study area within ecoregions is illustrated in Figure 7.6. The two offshore ecoregions, Southeast Atlantic and Southwest Indian, have the lowest number of species and records. The Natal (117) and Agulhas (101) ecoregions have the highest species richness, followed by the Southern Benguela (94) and Delagoa (86) ecoregions. The lowest number of records were also in the offshore ecoregions, Southeast Atlantic (63) and Southwest Indian (81) clearly indicating under-sampling in deeper regions and regions furthest from major cities or towns. The greatest number of records were found in the Agulhas (950) and Southern Benguela (513) ecoregions.

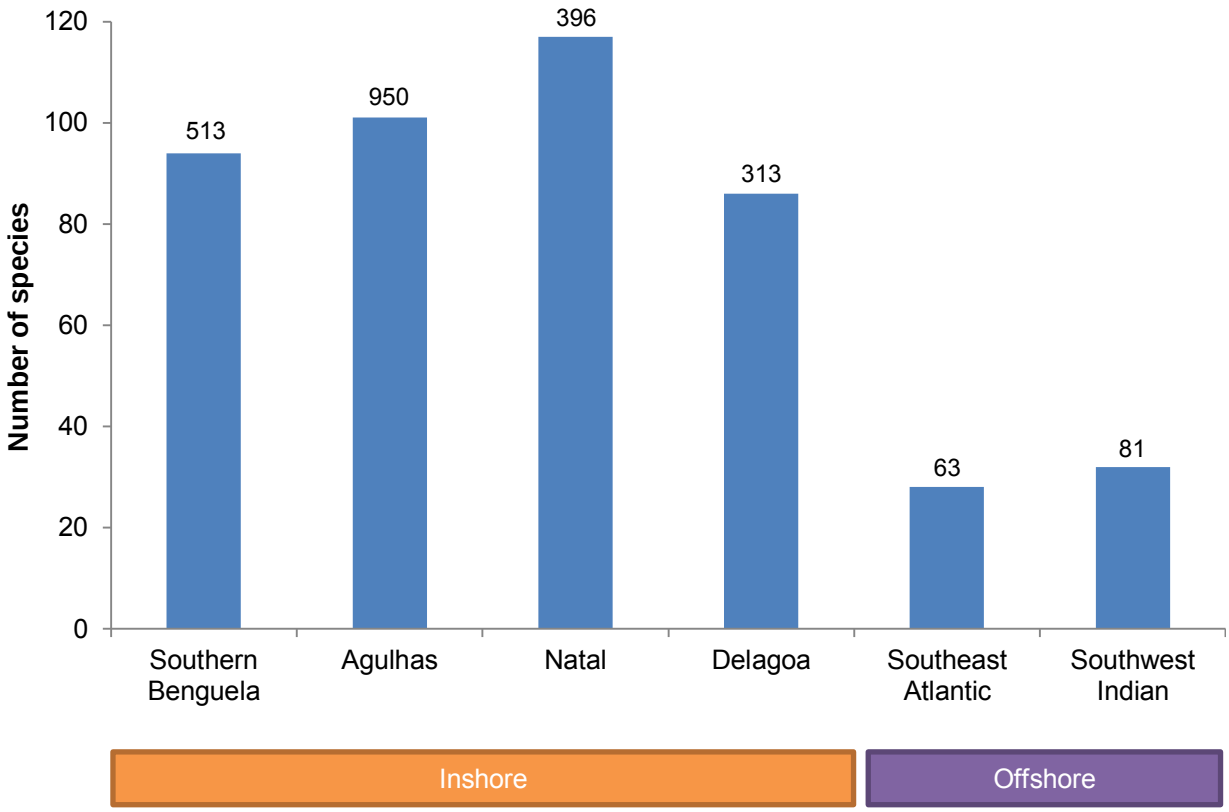

Figure 7.6. Species richness of South African Ophiuroidea grouped according to ecoregions as defined by Sink *et al.* (2012). The number of records are indicated on each bar.

Faunistic affinities and endemism

Of the 136 species known from South Africa, 33 (24.1%) are endemic (Table 7.4), but there are no endemic genera or families. In terms of biogeographic affinities, the 69 Indo-Pacific species (50.8%) make up the largest component, followed by 18 species classified as other (13.3%), while the 9 Atlantic (6.6%) and seven cosmopolitan species (5.2%) were the smallest groups.

Figure 7.7 shows the number of species and their affinities for the combined inshore and offshore dataset in the six ecoregions. Indo-Pacific species are found throughout the study area, but as would be predicted, the greatest proportion occurs in the Delagoa (48) and Natal (48) ecoregions, with only minimal occurrence in the Southern Benguela (7) and Southeast Atlantic (2) ecoregions. The Atlantic component was absent in the Southwest Indian ecoregion, but present in all other ecoregions. The small cosmopolitan component is present in all ecoregions occurring fairly uniformly across these. The highest numbers of endemic species were found in the Natal (25), Agulhas (19) and Southern Benguela (17) ecoregions, while the lowest number of endemic species was recorded in the Southeast Atlantic (2) ecoregion.

Table 7.4. Endemic Ophiuroidea species recorded from South Africa.

Family	Species
Gorgonocephalidae	*Astrocladus euryale* (Retzius, 1783)
	Astrocladus hirtus Mortensen, 1933
Ophiomyxidae	*Ophiomyxa tenuispina* Mortensen, 1933
	Ophiomyxa vivipara capensis Mortensen, 1936
	Ophioscolex inermis Mortensen, 1933
Amphilepididae	*Amphilepis scutata* Mortensen, 1933
Amphiuridae	*Amphioplus (Amphioplus) pectinatus* Mortensen, 1933
	Amphioplus (Unioplus) falcatus Mortensen, 1933
	Amphipholis similis Mortensen, 1933
	Amphipholis strata Mortensen, 1933
	Amphiura (Amphiura) acutisquama A.M. Clark, 1952
	Amphiura (Amphiura) albella Mortensen, 1933
	Amphiura (Amphiura) grandisquama natalensis Mortensen, 1933
	Amphiura (Amphiura) linearis Mortensen, 1933
	Amphiura (Amphiura) simonsi A.M. Clark, 1952
	Ophionephthys lowelli A.M. Clark, 1974
Ophiocomidae	*Ophiopsila bispinosa* A.M. Clark, 1974
Ophiotrichidae	*Ophiogymna capensis* (Lütken, 1869)
	Ophiothrix fragilis var. *triglochis* (Müller and Troschel, 1842)
Ophiuridae	*Ophiocten affinis simulans* (Mortensen, 1936)
	Ophiura (Dictenophiura) anoidea (Clark, 1923)
	Ophiura (Ophiura) trimeni Bell, 1905
	Ophiura (Ophiuroglypha) costata costata (Lyman, 1878)
Ophiacanthidae	*Ophiacantha nerthepsila* H.L. Clark, 1923
	Ophiacantha scutigera Mortensen, 1933
	Ophiacantha striolata Mortensen, 1933
	Ophiomitrella corynephora H.L. Clark, 1923
	Ophiomitrella hamata Mortensen, 1933
	Ophioplinthaca sexradia Mortensen, 1933
	Ophiothamnus remotus Lyman, 1878
	Ophiotreta durbanensis (Mortensen, 1933)
Ophiodermatidae	*Ophiochasma nitida* Hertz, 1927
	Cryptopelta aster (Lyman, 1879)

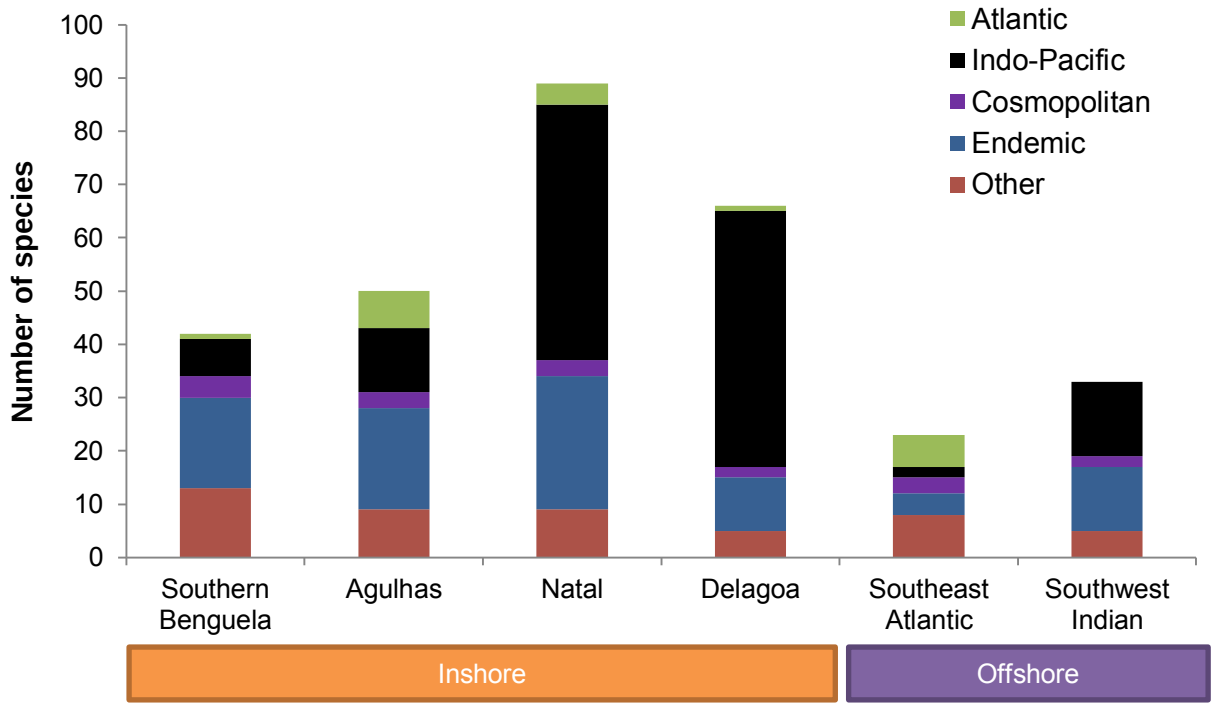

Figure 7.7. Number of South African Ophiuroidea species in each ecoregion, with their faunistic affinities.

Figure 7.8 shows the number of species in each depth category and their biogeographic affinities. The Atlantic and cosmopolitan species appear to be fairly uniform across the inshore (Atlantic: 2 (3.2%); cosmopolitan: 3 (4.8%)), with a small component of endemic species (11; 17.5%). On the shelf & slope, there is also a uniform spread of Atlantic and cosmopolitan species (Atlantic: 6 (9.5%); cosmopolitan: 5 (7.9%) but hosts the greatest number of endemic species (31; 49.2%). The bathyal also has a fair number of endemic species and an equal number of Atlantic (5; 7.9%) and cosmopolitan (5; 7.9%) species. As indicated above, only a single species (*Ophiura (Ophiuroglypha) irrorata irrorata*) is represented in the abyss (3501m+) and this species is known to be cosmopolitan. The Indo-Pacific category hosts the largest number of species in all depth categories (0-30m: 42; 31-500m: 39; 501-3500: 15) except the abyss (3501m+), but there appears to be no pattern with depth.

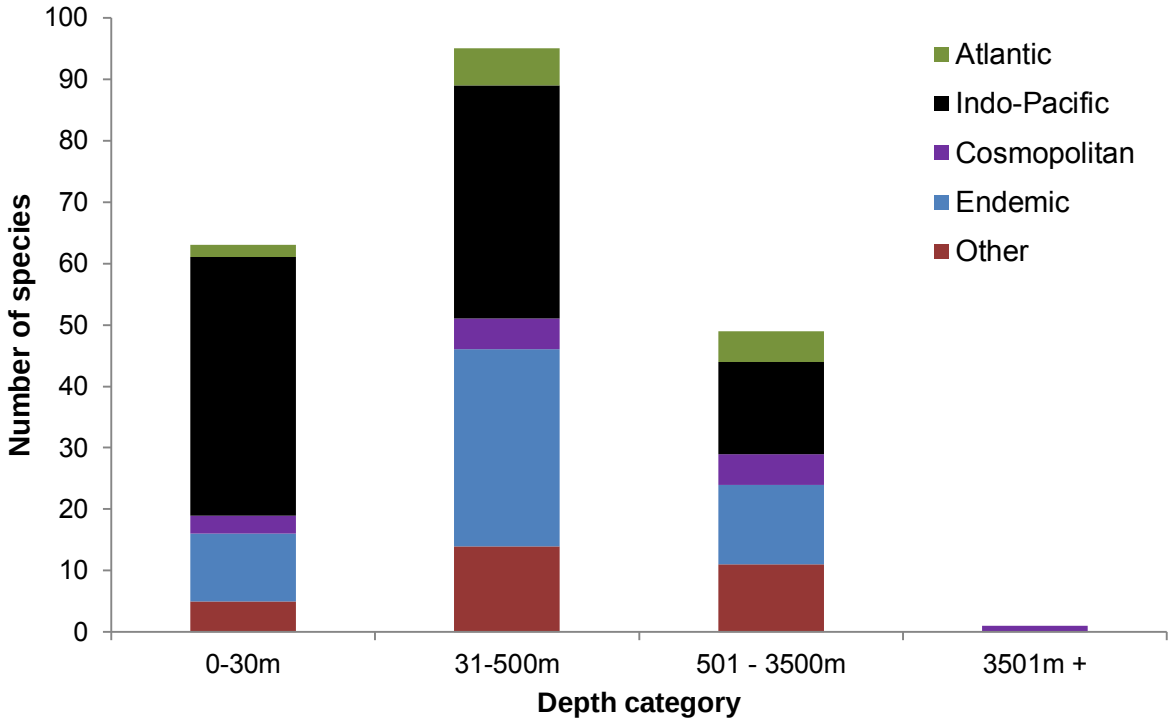

Figure 7.8. Faunistic affinities of species of South African Ophiuroidea recorded in each depth range.

The number of species in each ecoregion within each depth range is illustrated in Figure 7.9. The Natal (63) and Agulhas (42) ecoregions have the greatest number of species on the shelf & slope (31-500m), whereas the Delagoa (38) and Natal (24) have the greatest number in the inshore (0-30m). The greatest number of species in the bathyal (501-3500m) is in the Southwest Indian ecoregion (36). The only abyssal species (*Ophiura (Ophiuroglypha) irrorata irrorata*) was found in the Southeast Atlantic ecoregion.

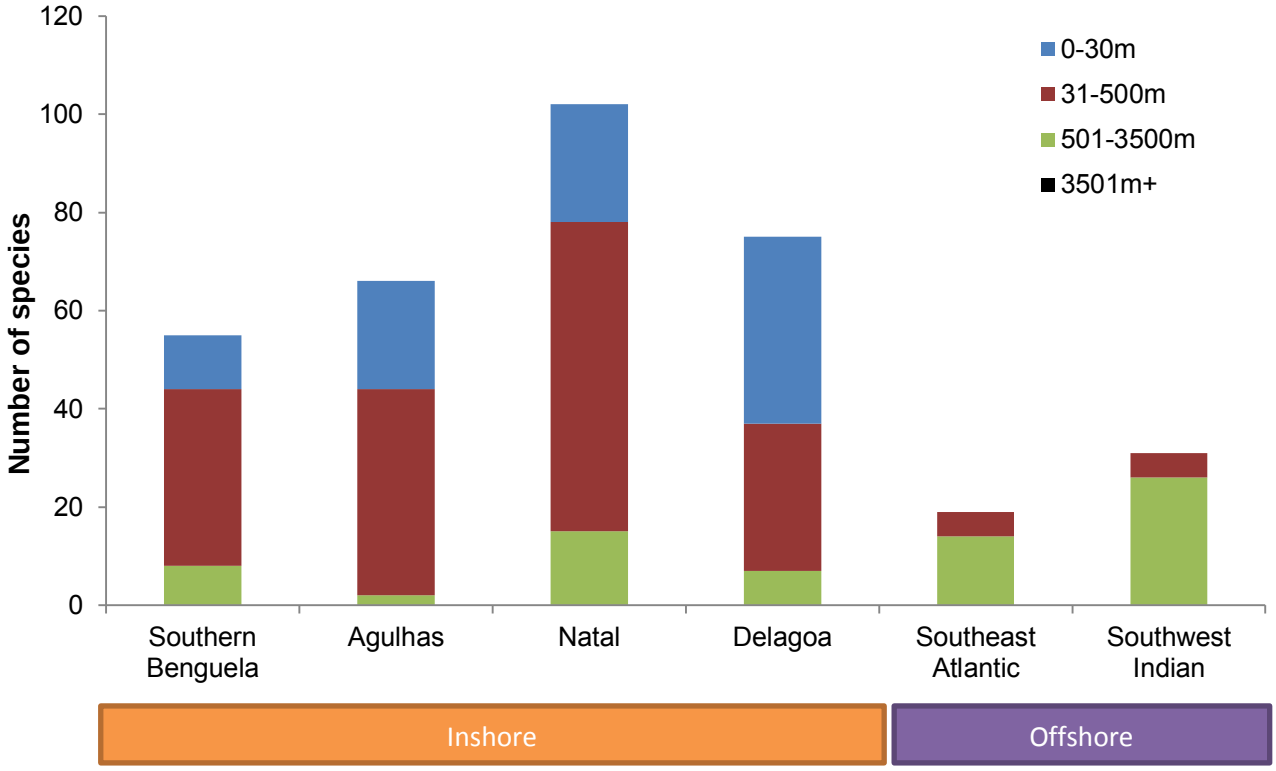

Figure 7.9. Number of South African Ophiuroidea species in each ecoregion, showing the contribution within each of the four depth categories.

ii) Inshore patterns

Species richness

A total of 955 records, representing 64 species, are included in the inshore analyses. In Figure 7.10, these are plotted per 100km section and it is evident the peaks in the number of records generally coincide with major towns, cities or areas because of ease of coastal access. The highest number of records are in section 9 (246 records) which coincides with Cape Town, followed by section 29 (154 records), which is in the vicinity of the popular dive resort of Sodwana Bay. Additional peaks are found in the vicinity of Saldanha Bay (section 7: 72), Durban (section 26: 52) and St Helena Bay (section 5: 46). The lowest numbers of records occurring in sections 1 (Port Nolloth), 2 (Kleinzee) and 17 (Tsitsikamma), while section 4 (Groen River) has no records.

Most species (51.6%) are known from five or less records, indicating that their true distribution is greatly under-estimated. Nine (14.1%) species are known from only one to two records. Thirteen species (4.4%) are known from more than 20 records with the maximum number of records for a single species being 171 (*Ophiothrix fragilis* var. *triglochis*).

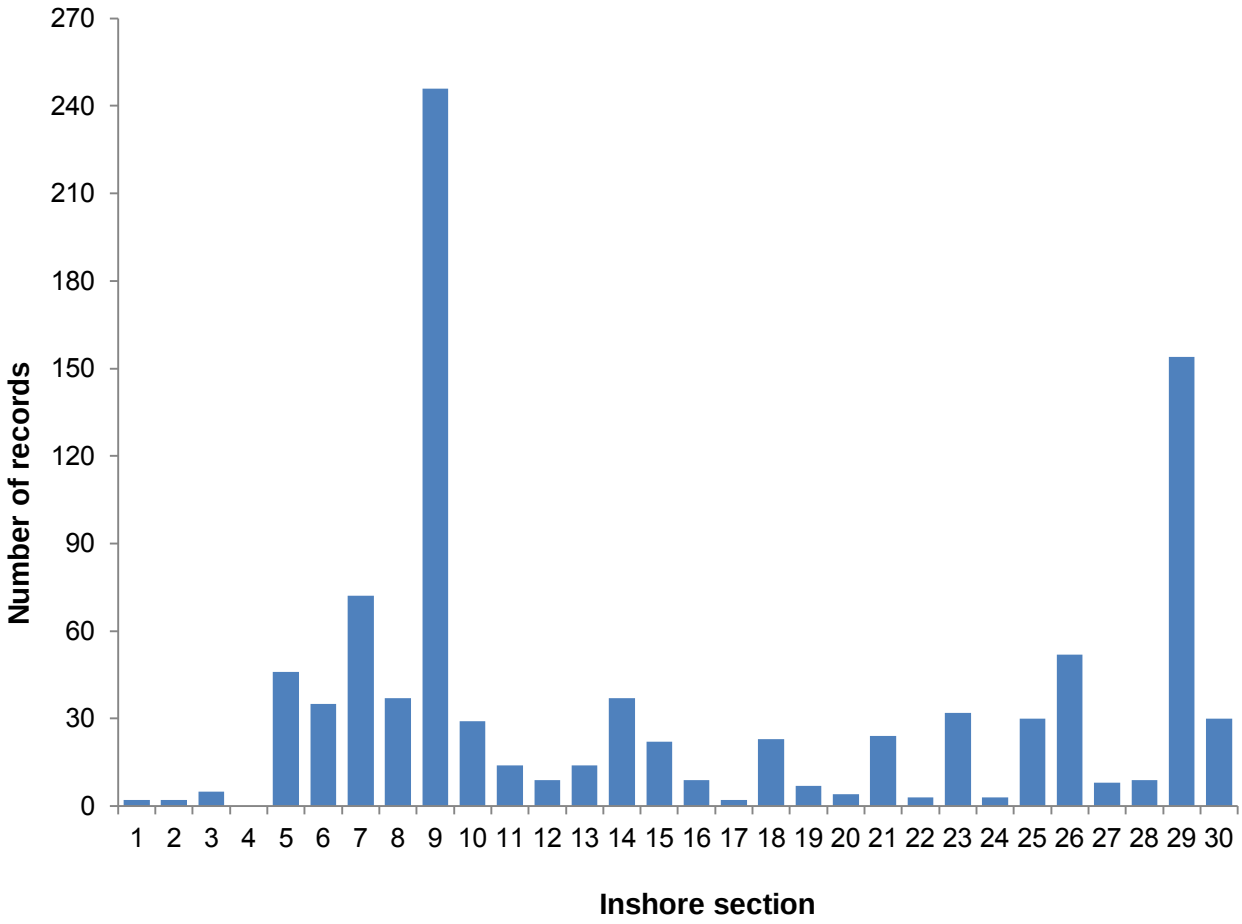

Figure 7.10. Number of records of South African Ophiuroidea in each 100km inshore section. Cities / towns include: 9-Cape Town; 18-Port Elizabeth; 21-East London; 26-Durban; 29-Sodwana Bay.

Faunistic affinities and endemism

The faunistic category with the greatest number of records along the entire coastline are those with Indo-Pacific affinity (135 records; 55%) followed by endemics, with 45 records (19%). The Atlantic species had the lowest number of records (seven records; 2%) while the cosmopolitan (24 records; 10%) and species classified as 'other' (35 records; 14%) contribute considerably.

The number of species recorded in each 100km section of coast and their biogeographic affinities are illustrated in Figure 7.11. The highest number of species are recorded in section 29 (38: Sodwana Bay) followed by section 30 (19: Kosi Bay) and Section 9 (18: False Bay). Species with an Atlantic affinity are confined to the west and south coasts, while the Indo-Pacific species appear on the west, south and east coasts. The cosmopolitan, endemic and species classified as 'other' occurred along the entire South African coastline.

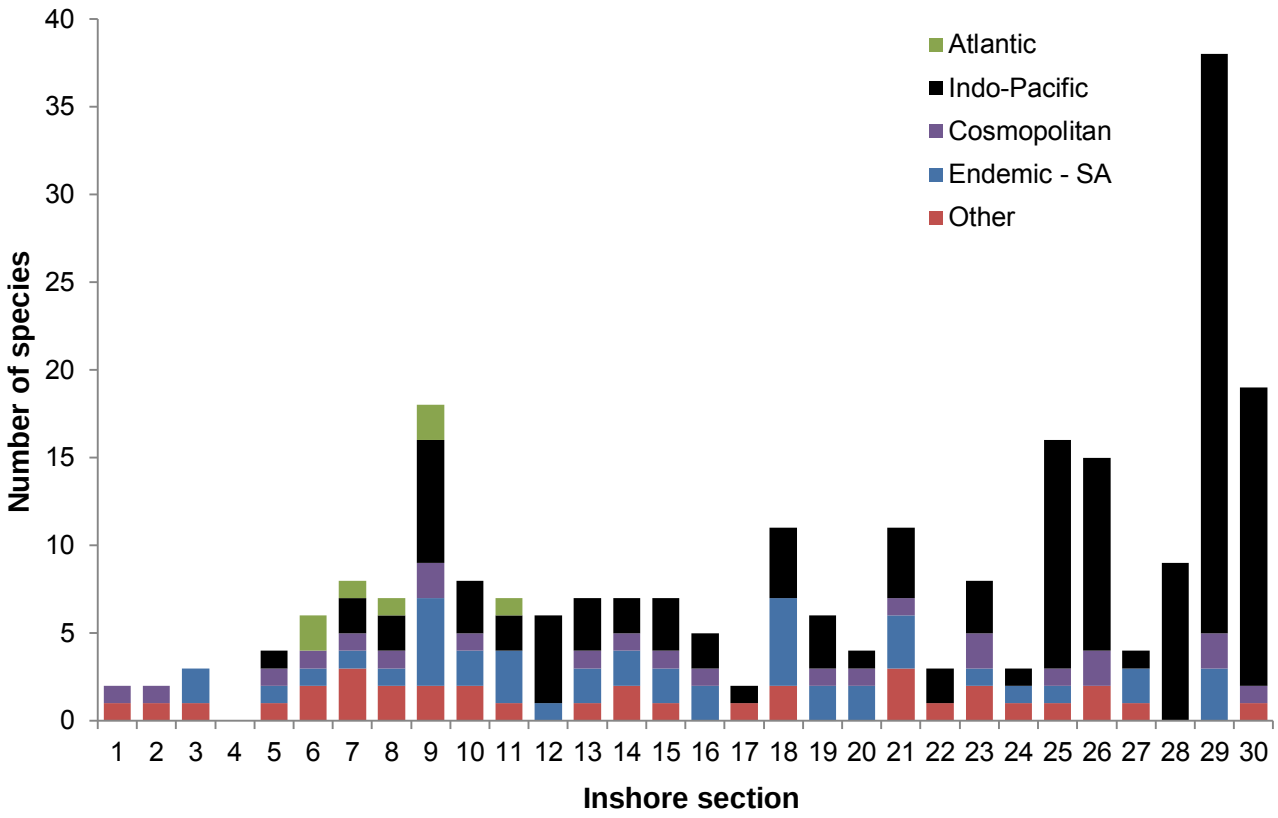

Figure 7.11. Number of species of Ophiuroidea reported in each 100km inshore section with associated biogeographical affinity. Cities / towns include: 9-Cape Town; 18-Port Elizabeth; 21-East London; 26-Durban; 29-Sodwana Bay.

Spatial patterns and diversity

In the multivariate analysis, at 60% similarity, five significant clusters are identified. The data conforms fairly well to the biogeographic ecoregions (Figure 7.12), as defined by Sink *et al.* (2012) and the historical biogeographic regions (Figure 7.13), as defined by Stephenson and Stephenson (1972). The data used in the multivariate analyses were interpolated between known localities which artificially create data points but is necessary for multivariate analysis.

The data, with associated factors (ecoregion and historical biogeographical regions) were subjected to ANOSIM tests (Table 7.5). All four inshore ecoregions except the Natal and Delagoa are significantly different. In the historical biogeographical regions, all three are also significantly different. Upon subjecting the clusters (similarity at 60%) to an ANOSIM, all clusters except B & D are significantly different (Table 7.6). In Figure 7.14, the clusters are overlaid onto the ecoregions. According to the SIMPROF, Cluster A (average similarity of 74.1%) is found in the Natal and Delagoa ecoregions. *Macrophiothrix demessa, Ophiactis savignyi, Ophiarachnella gorgonia, Ophiarachnella septemspinosa*, *Ophiocoma (Breviturma) brevipes*, *O. dentata, O. pusilla, Ophionereis porrecta, Ophiopeza fallax, Ophiothela venusta* and *Ophiothrix fragilis* each accounted for 5.0% of the similarity. *Amphipholis squamata*, *A. similis, Ophiactis carnea*, *O. savignyi*, *Ophiocoma scolopendrina*, *O. pica, Ophionephthys lowelli, Ophionereis dubia, O. porrecta* and *Ophiothrix fragilis* accounted for similarity in Cluster B (average similarity: 82.9%) with 10.1% each. *Amphioplus (Lymanella) integer, Amphipholis squamata, Amphiura (Amphiura) angularis, Astrocladus euryale, Ophiactis carnea, Ophiarachnella capensis, Ophionereis dubia, O. porrecta* and *Ophiothrix fragilis* accounted for similarity in Cluster C (average similarity: 7.2%). Both Cluster B and C are recorded mostly in the Agulhas ecoregion.

Amphioplus (Lymanella) integer, Amphipholis squamata, Amphiura (Amphiura) capensis, Ophioderma wahlbergii and *Ophiothrix fragilis* contributed the most to similarity in Cluster D (average similarity: 86.7%) found in the Southern Benguela ecoregion, while similarity in Cluster E (average similarity: 79.8%) is mostly as a result of the contribution by *Amphipholis squamata* and *Amphiura capensis* (47.0%), which is mostly found in the Southern Benguela. The greatest dissimilarities are found between the Agulhas and Delagoa ecoregions (95.2%) and the Southern Benguela and Delagoa (85.0%) ecoregions.

Table 7.5. Results of a one-way analysis of similarities (ANOSIM) for the inshore data used in a biogeographical study of South African Ophiuroidea. Data were untransformed, non-standardised and were significantly different at <5%, ($\propto$ = 0.05). Values that are significantly different are printed in bold.

		R-Statistic	Significance level
Ecoregions	Global R value: 0.916 Significance level of sample statistic: 0.1%		
	Southern Benguela; Agulhas	**0.872**	**0.1**
	Southern Benguela; Natal	**0.995**	**0.4**
	Southern Benguela; Delagoa	**1.000**	**2.8**
	Agulhas; Natal	**0.960**	**0.1**
	Agulhas; Delagoa	**1.000**	**0.8**
	Natal; Delagoa	0.479	10.7
Historic	Global R value: 0.889 Significance level of sample statistic: 0.1%		
	West; South	**0.831**	**0.1**
	West; East	**0.998**	**0.1**
	South; East	**0.926**	**0.1**

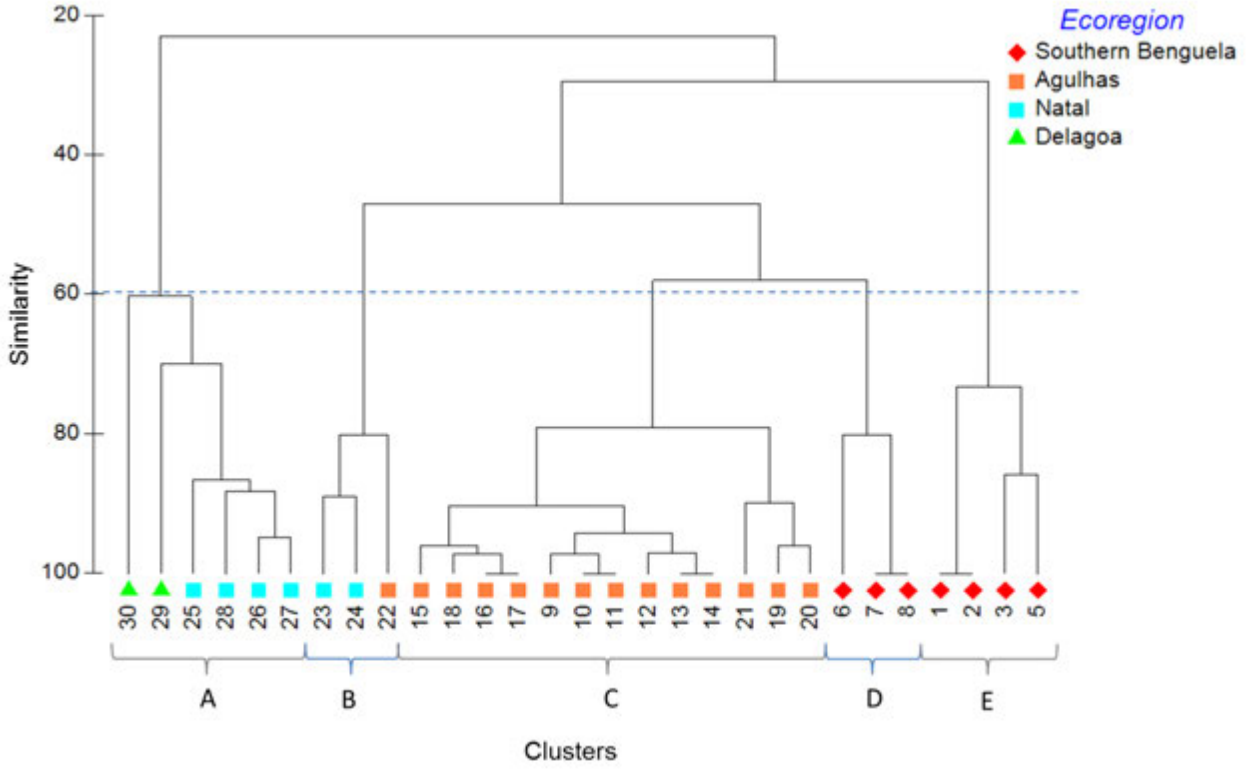

Figure 7.12. Agglomerative hierarchical clustering based on the Bray-Curtis similarity measure at 60% on untransformed and non-standardised inshore data used in a biogeographical study of South African Ophiuroidea. Ecoregions, as defined by Sink *et al.* (2012), added as a factor with the five clusters indicated below the x-axis.

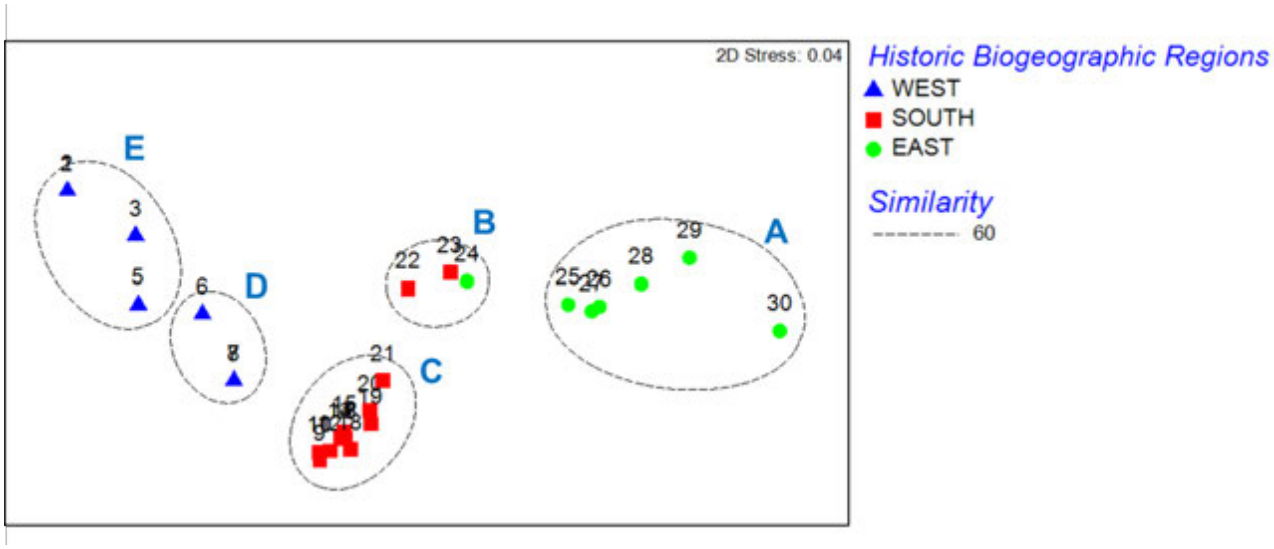

Figure 7.13. Two dimensional MDS configuration of inshore species data. The Bray-Curtis similarity measure at 60% on untransformed, non-standardised data with a Kruskal stress of 0.04, used in a biogeographical study of South African Ophiuroidea. Historic biogeographic regions, as defined by Stephenson and Stephenson (1972) were added as a factor.

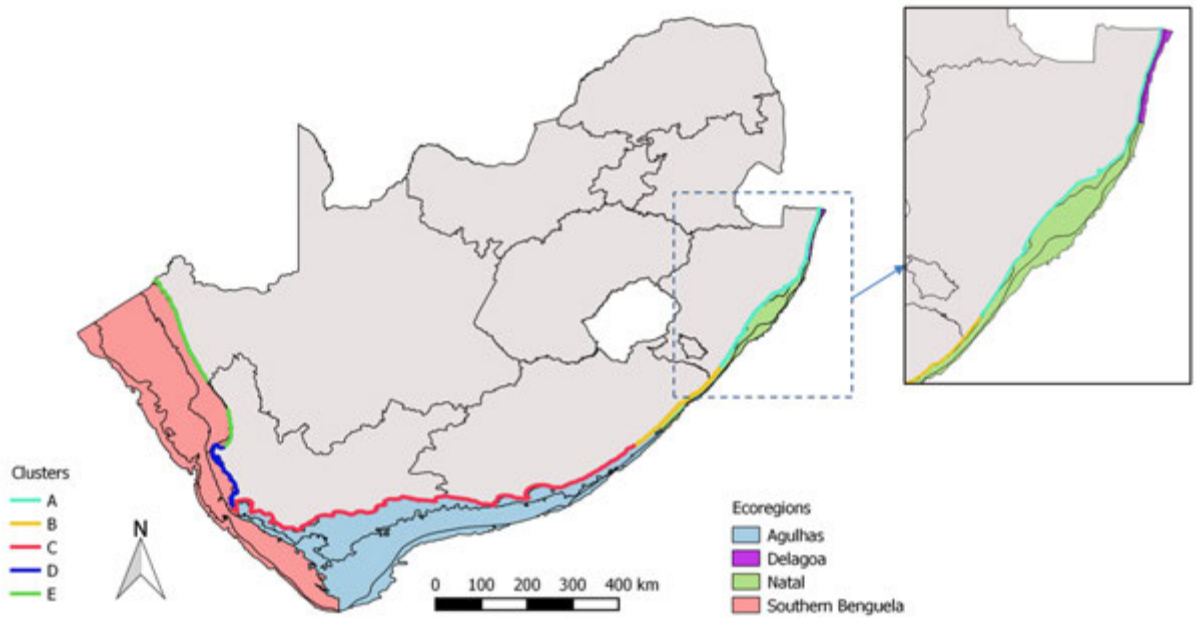

Figure 7.14. Significant clusters mapped in QGIS overlaid on the inshore ecoregions as defined by Sink *et al.* (2012), used in a biogeographical study of South African Ophiuroidea.

Table 7.6. Results of a one-way analysis of similarities (ANOSIM) between five distinct clusters as defined by species presence / absence within inshore sections along the South African coastline, in a biogeographical study of South African Ophiuroidea. Data were untransformed, non-standardised and significantly different at <5%, ($\propto$ = 0.05). The global R was 0.984 and the significance level was 0.1%. Values that are significantly different are printed in bold.

Cluster	R-Statistic	Significance level
E, D	**0.907**	**2.9**
E, C	**1.000**	**0.1**
E, B	**1.000**	**2.9**
E, A	**1.000**	**0.5**
D, C	**0.991**	**0.2**
D, B	1.000	10.0
D, A	**1.000**	**1.2**
C, B	**0.992**	**0.2**
C, A	**1.000**	**0.1**
B, A	**0.870**	**1.2**

For the purposes of measuring species turnover, or rate of change in species composition along the coastline, the species data were interpolated (see methods). Species turnover is indicated by the rapid decrease or increase of ß-diversity on the graph (Figure 7.15). The values of ß-diversity across the coastline varied between 0 and 1.34 and there was a low level of turnover between sections 9 to 21, where $ß_T$ = 0.97-1.06. A rapid change in species turnover occurred between sections 1 to 4 ($ß_T$ ranged between 0.67-1.14), sections 7 to 9 ($ß_T$ = 1-0.69), 21-26 ($ß_T$ = 0.74-1.14) and 29-30 ($ß_T$ = 0.82-1.34). The rate of change in sections 1-4 is most probably due to low sampling intensity from the Namibian border up to section 4, while the other sections demonstrating rapid species turnover coincide with clustering from the multivariate analysis, which roughly correlates to known biogeographical breaks.

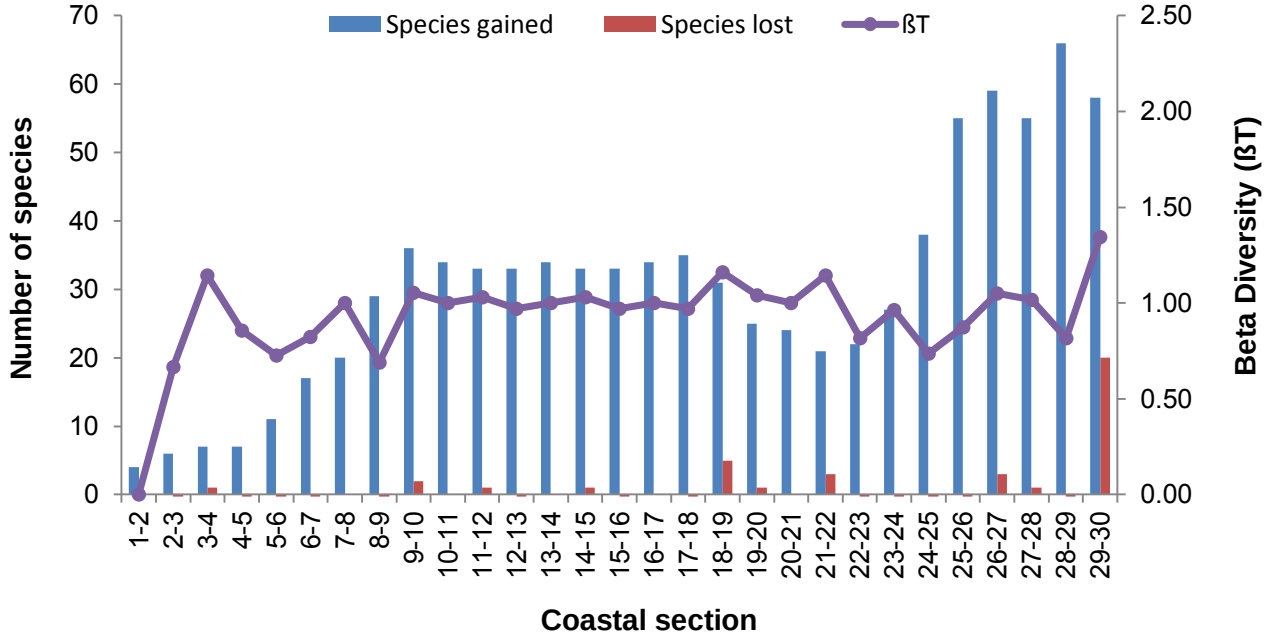

Figure 7.15. Number of species gained and lost with the species turn over index ($ß_T$) in adjacent inshore sections used in a biogeographical study of South African Ophiuroidea. Sections 7-9: Saldanha to Cape Point; 21-23: Great Fish River to Hluleka (including the Mbashe River); 28-29: Cape Vidal to Black Rock.

iii) Offshore patterns

Species Richness

A total of 1311 records representing 113 species were included in the offshore analyses (defined as greater than 30m depth). Only 104 of the possible 500 QDGC's within the study area contained Ophiuroidea data. Figure 7.16 shows the number of records and species per QDGC for the offshore dataset. Twenty-two QDGC's contained a single record (21.2%) and 50 (48.1%) contained less than 10 records. The highest number of records in a single QDGC was 169, while six contained 50 or more records. The QDGC with the most number of records were closest to the coastline around Cape Town, south of Durban and in Sodwana Bay. The greatest numbers of records per QDGC were 169 and 109, both in the vicinity of Cape Town.

The QDGC's with the highest number of species were also adjacent to the major cities of Cape Town, between Durban and Richards Bay and in the vicinity of Sodwana Bay. The number of species recorded offshore was highest on the west coast, moderately high on the south coast and very low on the east coast. Due to low sampling effort, the almost complete absence of data in QDGC's distant from the coastline along the entire east coast is particularly noticeable.

Most species (69.0%) were known from five or less records, indicating that true distribution is under-estimated, similar to the inshore. Twenty-three (20.3%) species were known from a single record, while 20 (17.7%) were known from two records. Five species (4.4%) were known from more than 50 records, with the maximum number of records for a single species being 95 (*Ophiothrix fragilis* var. *triglochis*).

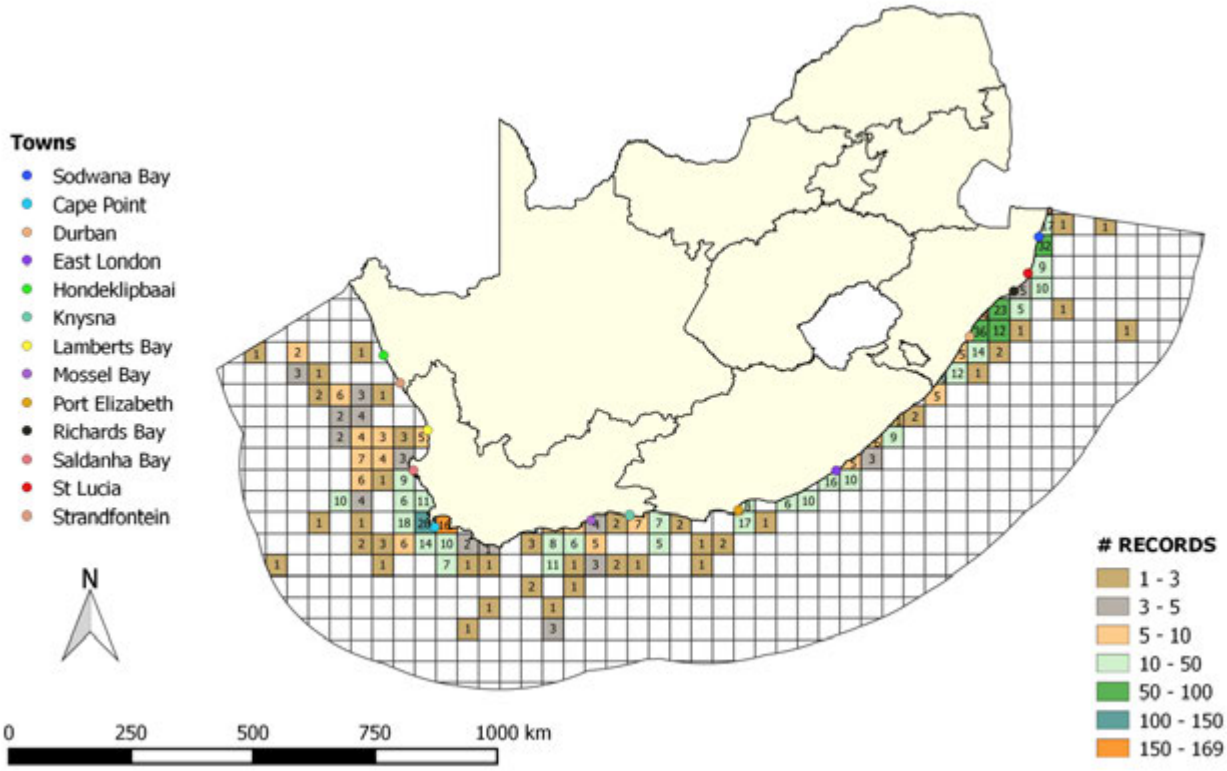

Figure 7.16. Map of Quarter Degree Grid Cells (QDGC) within the study area showing the number of data records and numbers of species per grid square in the offshore dataset (depth >30m).

Faunistic affinities and endemism

Figure 7.17 shows the number of offshore species in each faunistic category. The greatest number, 47 species (41.6%), had Indo-Pacific affinities, followed by 31 endemic species (27.4%) and 20 'other' species (17.7%). The Atlantic and cosmopolitan species accounted for the lowest number of species with 8 (7.1%) and 7 (6.2%), respectively.

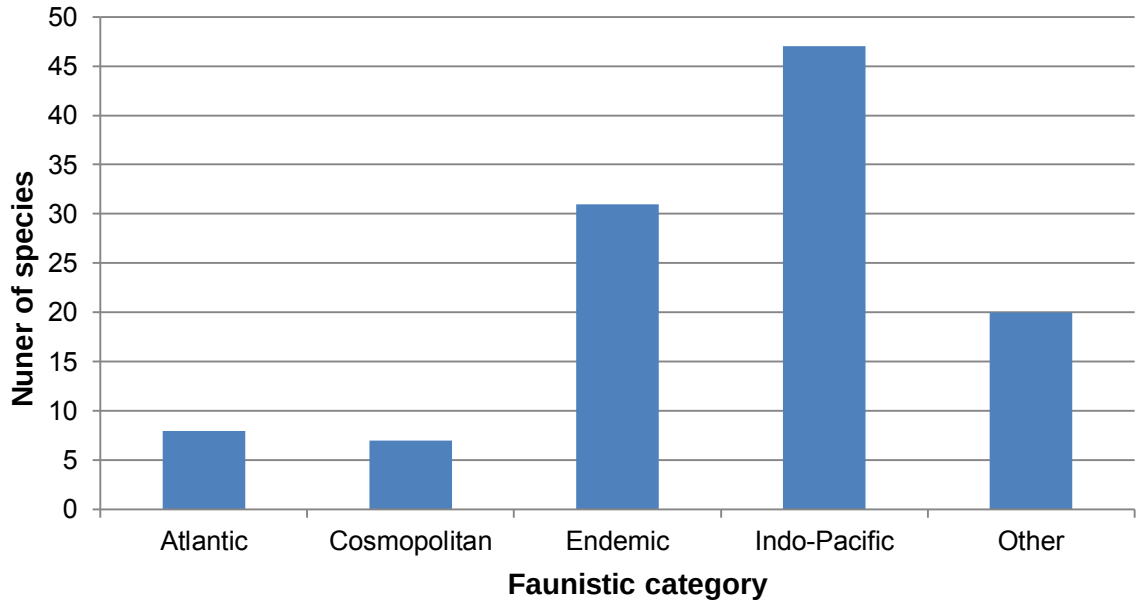

Figure 7.17. The number of species of offshore (>30m depth) South African Ophiuroidea in each faunistic category.

Spatial patterns and diversity

In the multivariate analysis, at 22% similarity, four significant clusters were identified (Figure 7.18 and 7.19). In comparison to the inshore data, the numbers of offshore records are fewer in number and spread over a larger area, therefore it would be expected that similarities in the data would be lower and contain many outliers (9). The offshore data did not conform particularly well to the ecoregions or historical biogeographical regions (Figure 7.19) as defined by Sink *et al.* (2012) and Stephenson and Stephenson (1972), respectively.

Table 7.6 shows the ANOSIM results for the six ecoregions. All ecoregions except the Delagoa and Southwest Indian, Delagoa and Natal, Southern Benguela and Southeast Atlantic and Natal and Southwest Indian ecoregions were significantly different from each other. In Figure 7.20, the clusters are overlaid onto the ecoregions. According to the SIMPROF, seventy percent of the samples within Cluster A (average similarity of 52.9%) were found in the Southern Benguela ecoregion, with *Ophiura* (*Ophiuroglypha*) *costata costata* (39.7%), *Ophiothrix (Ophiothrix) aristulata* (18.4%) and *Asteronyx loveni* (12.9%) accounting for the majority of the similarity. Cluster B found in the Southwest Indian and Agulhas ecoregions (average similarity: 38.4%) were characterised by similarities of *Astrocladus euryale* (56.7%), *Ophiothrix fragilis* var. *triglochis* (12.6%), *Ophiacantha nerthepsila* (9.7%) and *Ophiothrix (Ophiothrix) aristulata* (5.4%). *Ophiothrix fragilis* var. *triglochis* (9.2%), *Ophiura* (*Dictenophiura*) *anoidea* (7.4%), *Ophiactis carnea* (6.1%) and *Amphipholis squamata* (5.8%) contributed the most to similarity in Cluster C (average similarity: 47.8%) which was found in the Southeast Atlantic and Agulhas ecoregions, while *Amphiura (Amphiura) grandisquama natalensis* (5.7%), *Ophiothamnus remotus* (4.5%) and *Amphiura* (*Amphiura*) *albella* (4.1%), found in the southwest Indian, Natal and Delagoa ecoregions, characterised similarity in Cluster D.

Table 7.7 showed the ANOSIM results for the four significant clusters. The greatest dissimilarity was found between the Delagoa and Agulhas (90.5%), whereas the lowest dissimilarity was between Southern Benguela and Southeast Atlantic (56.5%) ecoregions, which was mostly as a result of the occurrence of *Amphiura (Amphiura) atlantica, Ophiomitrella corynephora* and *Ophiolycus dentatus.*

Table 7.6. Results of a one-way analysis of similarities (ANOSIM) for the offshore QDGC species data, of South African Ophiuroidea. Data were untransformed, non-standardised and significantly different at <5%, ($\propto$ = 0.05). The global R was 0.379 and the significance level was 0.1%. Values that are significantly different are printed in bold.

Ecoregions	R-Statistic	Significance level
Delagoa, Southwest Indian	-0.038	44.2
Delagoa, Natal	0.302	14.3
Delagoa, Southern Benguela	**0.890**	**0.2**
Delagoa, Southeast Atlantic	**0.851**	**0.4**
Delagoa, Agulhas	**0.894**	**0.2**
Southwest Indian, Natal	-0.177	90.9
Southwest Indian, Southern Benguela	**0.592**	**0.1**
Southwest Indian, Southeast Atlantic	**0.398**	**0.1**
Southwest Indian, Agulhas	**0.416**	**0.1**
Natal, Southern Benguela	**0.749**	**0.1**
Natal, Southeast Atlantic	**0.560**	**0.2**
Natal, Agulhas	**0.615**	**0.1**
Southern Benguela, Southeast Atlantic	0.022	22.0
Southern Benguela, Agulhas	**0.345**	**0.1**
Southeast Atlantic, Agulhas	**0.237**	**0.1**

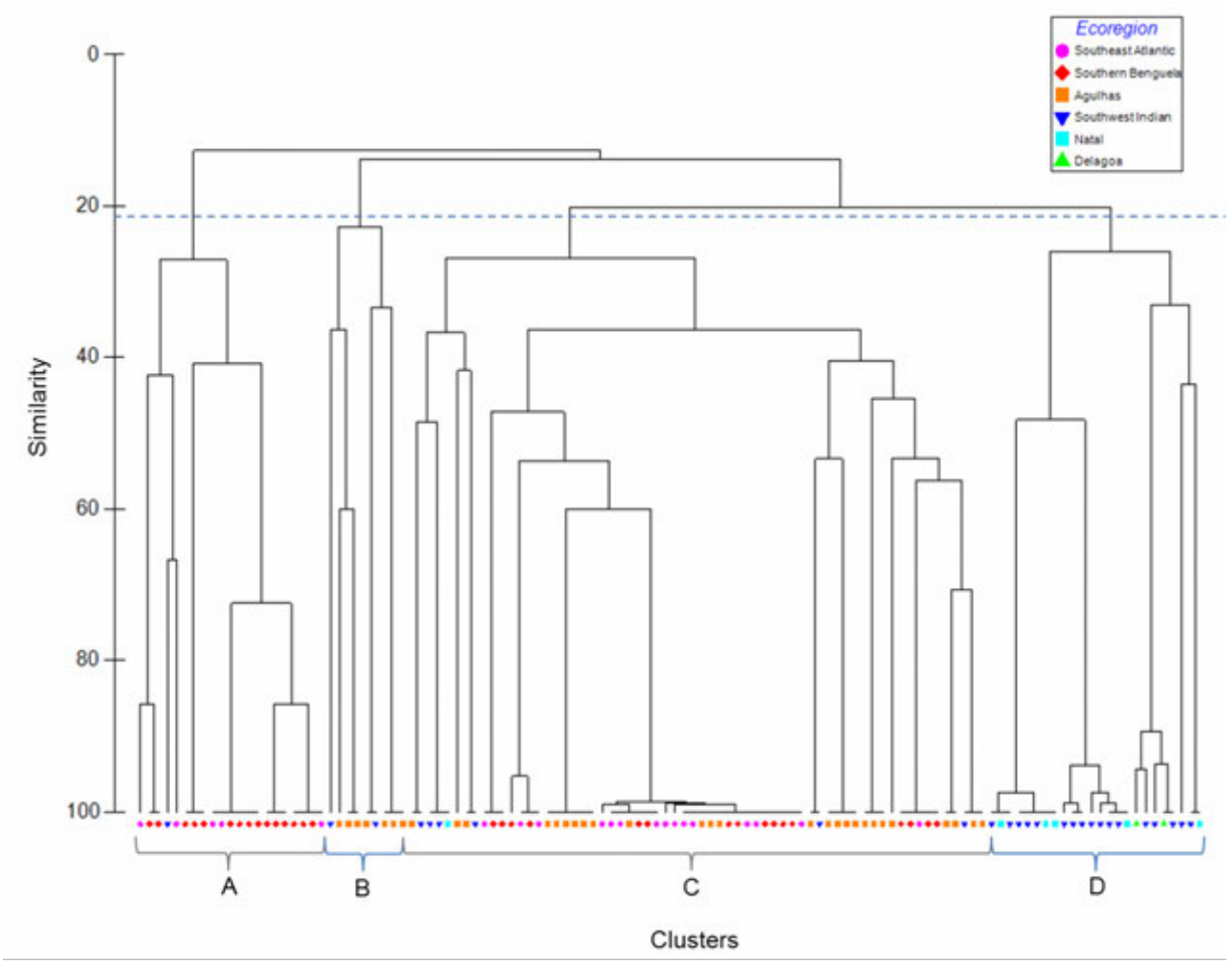

Figure 7.18. Agglomerative hierarchical clustering based on the Bray-Curtis similarity measure at 22% on untransformed and non-standardised offshore data used in a biogeographical study of South African Ophiuroidea. Ecoregions, as defined by Sink *et al.* (2012), added as a factor with the three clusters indicated on the x-axis.

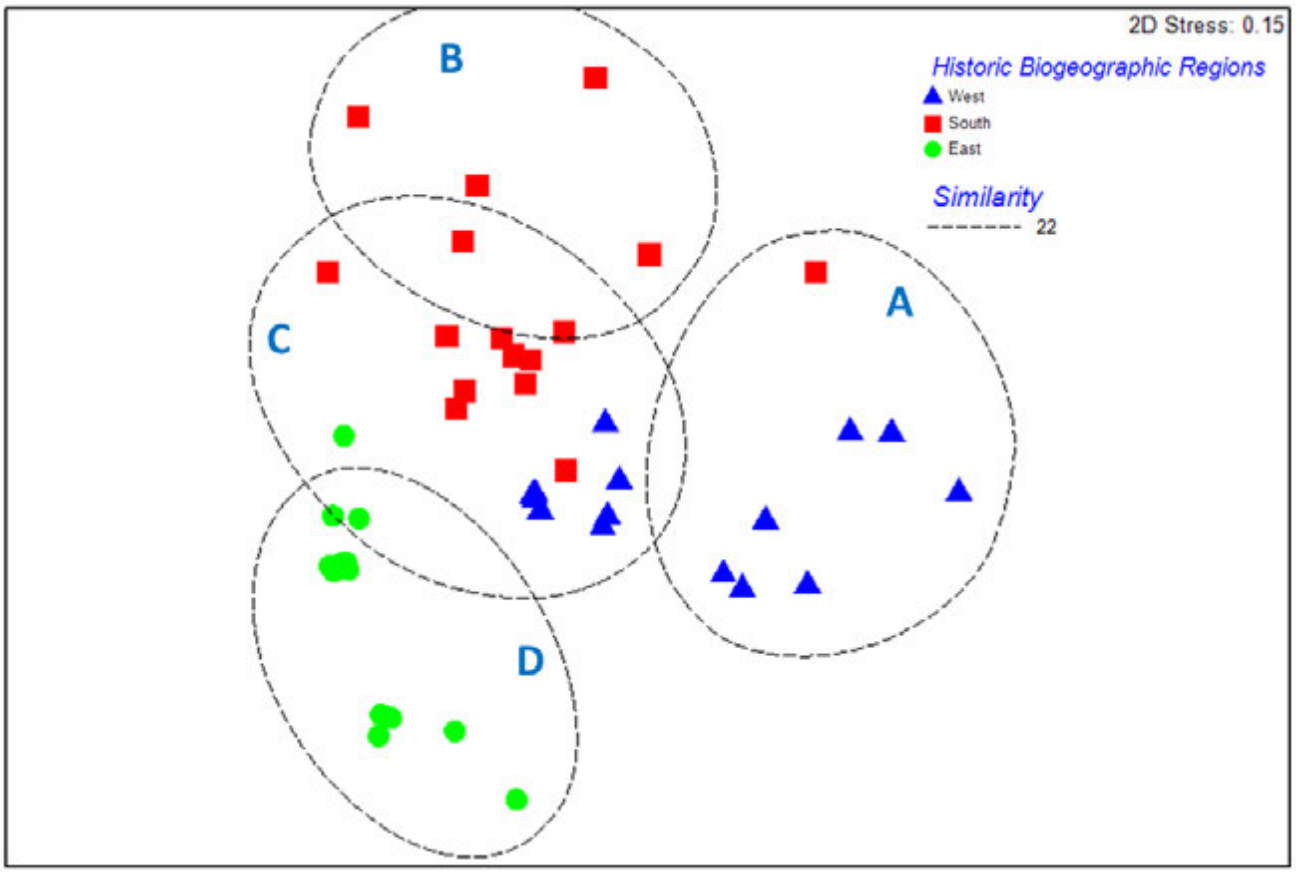

Figure 7.19. Two dimensional MDS configuration of offshore species data of South African Ophiuroidea. The Bray-Curtis similarity measure at 22% on untransformed and non-standardised data with a Kruskal stress of 0.15, Historic biogeographic regions, as defined by Stephenson and Stephenson (1972) were added as a factor.

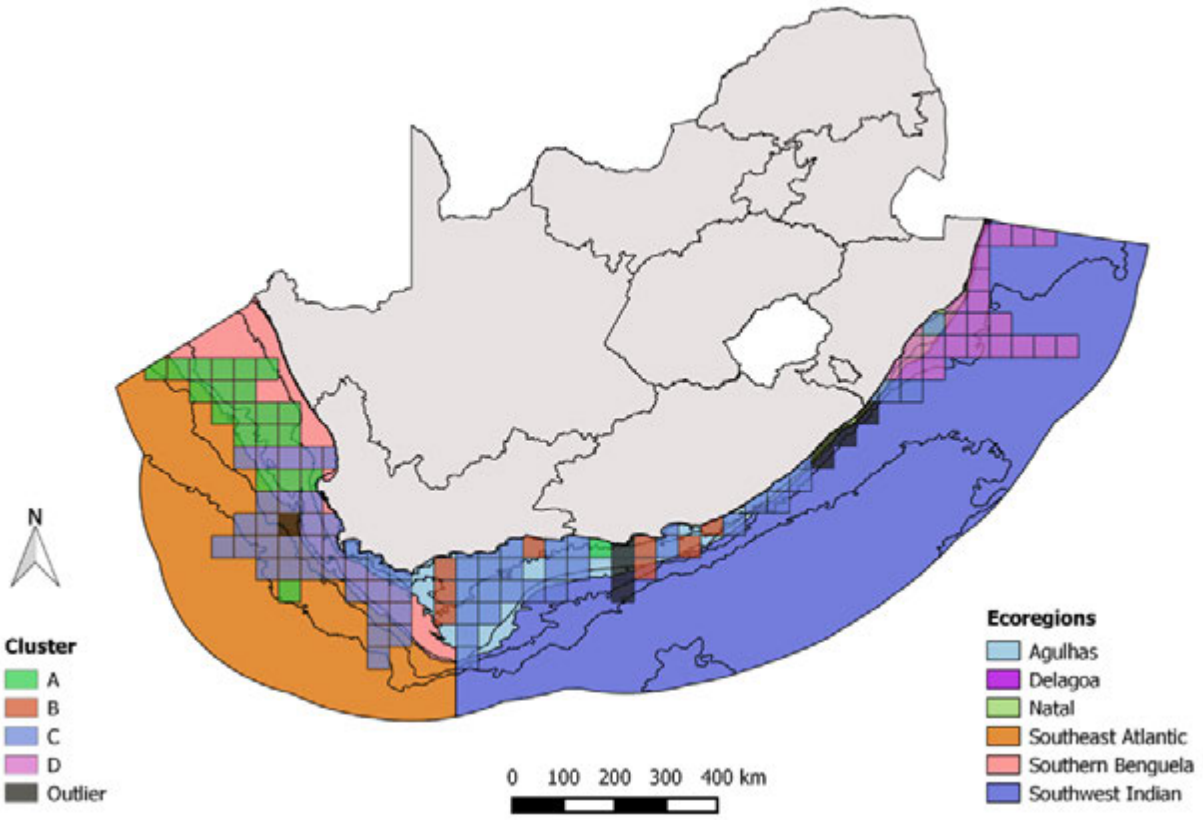

Figure 7.20. Quarter degree grid cells (QDGC) making up the significant clusters of South African Ophiuroidea overlaid on the ecoregions as defined by Sink *et al.* (2012).

Table 7.7. Results of a one-way analysis of similarities (ANOSIM) between four distinct clusters as defined by species presence / absence within the offshore QDGC species data. Data were untransformed, non-standardised and significantly different at <5%, ($\propto$ = 0.05). The global R was 0.847 and the significance level was 0.1%. All clusters were significantly different.

Clusters	R-Statistic	Significance level
D, C	0.814	0.1
D, A	0.980	0.1
D, B	0.946	0.1
C, A	0.829	0.1
C, B	0.833	0.1
A, B	0.899	0.1

In order to measure species turnover or rate of change in species from west to east, species data were required to be interpolated (see methods). Species turnover was indicated by the rapid decrease or increase of ß-diversity on the graph (Figure 7.21). The values of ß-diversity from west to east within the South African EEZ varied between 0 and 1.75. There was minimal species turnover between transects South 11-12 to East 7-8 where $ß_T$ = 0.99-1.11. The greatest species turnover was between transects West 1-2 to West 6-7 ($ß_T$ = 0.00-1.00), West 11-12 to South 10-11 ($ß_T$ = 0.83-1.14) and East 7-8 to East 10-11 ($ß_T$ = 0.71-1.75), which roughly correlated to known biogeographical breaks. Similarly to the inshore, the boundaries of the EEZ showed a high species turnover (transects West 1-5: $ß_T$ = 0.00-0.83) and (transects East 7 to 11: $ß_T$ = 1.04-1.75).

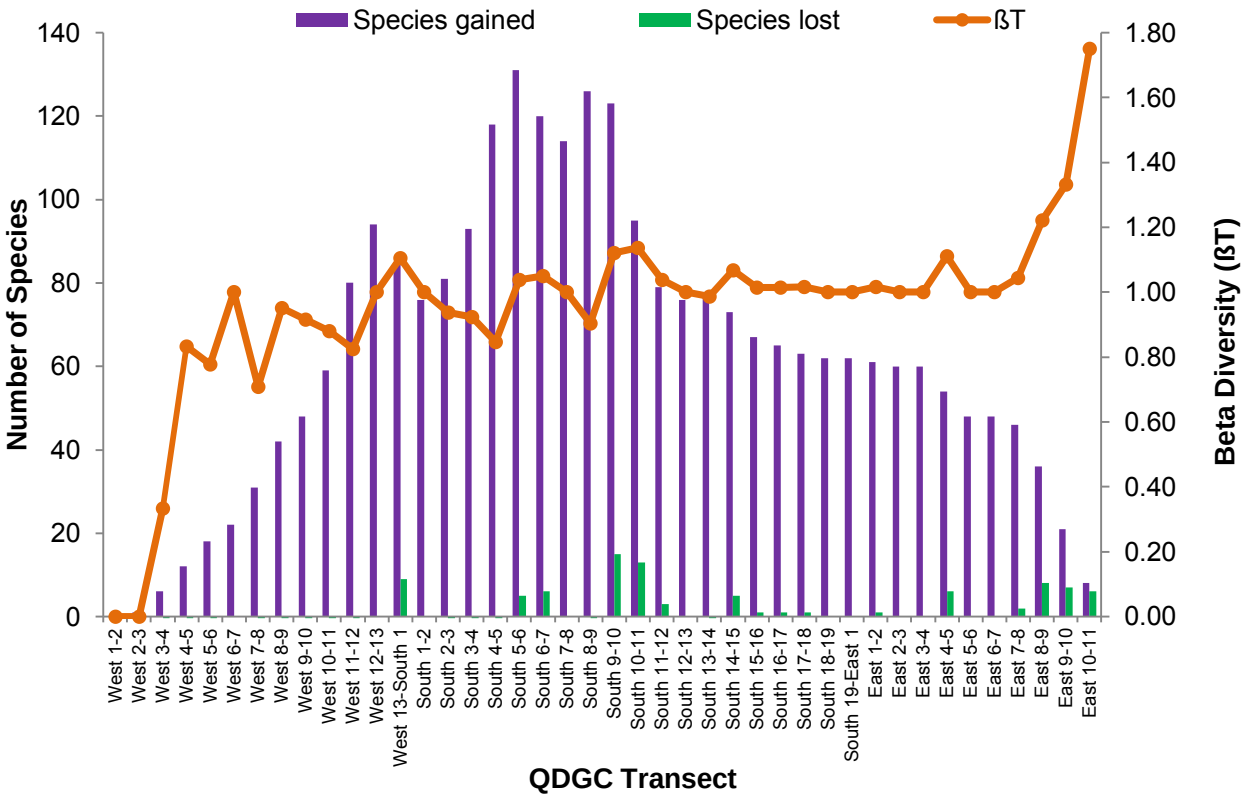

Figure 7.21. Number of species gained and lost with the species turnover index ($ß_T$) in QDGC transects perpendicular to the coastline to the boundary of the EEZ. Transect West 12: Cape Point; South 1: Cape Agulhas; South 12: Port Elizabeth; East 1: Mbashe River; East 5: Durban; East 8: Cape Vidal.

DISCUSSION

The South African coastline consists of a myriad of mixed habitats, with 38% sandy shores, 32% mixed shores, 29% rocky shores and 1% estuaries, river mouths and harbours (Harris *et al.*, 2011; Sink *et al.*, 2012). The offshore habitat includes seamounts, banks, canyons, deep reefs, and an enormous variety of sediment types (Lombard *et al.*, 2004, Sink *et al.*, 2012). Ophiuroidea occur in all these habitats, from the shore to the abyss, and this would suggest that they are good representatives for biogeographic classification within the South African EEZ, even though sampling effort is not uniform throughout the study area.

Study area, data availability and dataset consolidation

The number of records available in both the inshore and offshore datasets provided a good opportunity to re-examine the biogeography, species richness, faunistic affinities, depth distribution and endemicity of the Ophiuroidea in South Africa.

A total of 2266 data points are included in this study, 1478 of which are new. The records are concentrated along the inshore and even the offshore records are concentrated adjacent to the coast, with very few extending towards the boundary of the EEZ. It is, however, typical of these types of studies that sampling is not evenly distributed. There was also a marked lack of deep-water samples, with only a single record from the abyss (3500m+).

The results illustrate that over 50% of inshore species and 69% of offshore species are known from five records or less, defining them as 'rare'. It is believed that such rarity is a product of under-sampling, in both the inshore and offshore areas. Ophiuroidea are generally cryptic and / or nocturnal, which make them easily missed in both hand-sampling and by dredging or trawling, especially considering that most sampling occurs during the day. Therefore, it is believed that the true distribution and diversity is greatly under-represented, similarly to most invertebrate groups, largely due to a combination of inadequate sampling and historical lack of taxonomic expertise on echinoderms in South Africa (Gibbons *et al.*, 1999; Griffiths *et al.*, 2010).

Sampling methods over time

Scientific SCUBA diving only became popular in 1952 when the Australian CSIRO began to use SCUBA as a research tool. In South Africa, SCUBA as a method of collection only began in 1967. In this study, the difference between SCUBA and hand-collected samples were found to be ill-differentiated in the data, as some SCUBA expeditions logged their collection methods as 'by hand'. The two methods were thus pooled in the analysis.

Today, dredging, trawling, SCUBA and hand-collections are all being undertaken, but since 2001, there has been an increasing dataset for samples obtained by ROV's. In 2008, the South African Institute for Aquatic Biodiversity (SAIAB), with a grant through the Department of Science and Technology and the National Research Foundation, procured South Africa's first ROV for Marine Research and has been undertaking research ever since. In addition, the national Department of Agriculture, Forestry and Fisheries (DAFF), the South African Environmental Observer Network (SAEON), SANBI, and SAIAB are making a considerable effort to increase the number of samples obtained from the deep-sea (Lara Atkinson and Kerry Sink, pers. comm.). The result of these surveys will improve our knowledge of areas where no data are currently available, especially in very deep waters, where sampling has not been undertaken for many decades (Griffiths *et al.*, 2010).

There was an increase in the last decade in the use of photographs to identify and increase distribution data coverage. However, unlike the Asteroidea and Echinoidea, many Ophiuroidea and Holothuroidea are not easy to identify using photographs. The value of Ophiuroidea photographs lies in the opportunity to document a range size classes and colour morphologies of species that are easily identifiable. Platforms such as iSpot and EchinoMAP rely on citizen scientists to load their images, but also require experts to give feedback. Silvertown *et al.* (2015) highlighted initiatives such as iSpot which combines technology with crowdsourcing and connects beginners with experts, thus increasing knowledge of geographical distribution of species.

Distribution range

Clark and Courtman-Stock (1976), using the same method as Day (1967a), listed the degree cells in which each species occurred. This method has the potential to over-exaggerate the true distribution of species because they use species ranges rather than occurrence records. Nevertheless, these historical ranges were compared to the new data found during this study. The distribution of each species is mapped in Chapter 6 by plotting their actual individual distribution records, which has never been done for South African Ophiuroidea before. Twenty-three species, 16% of known Ophiuroidea species for South Africa, demonstrated range extensions since Clark and Courtman-Stock (1976), which again suggests under-sampling or variable effort in sampling intensity.

Depth analysis

In a global diversity review of Ophiuroidea, Stöhr *et al.* (2012) stated that 'South Africa', not referring to the country, but rather the region (from 30ºS to 60ºS and 20ºW to 90ºE), contained a unique diversity of species which warranted it being included as one of 12 regions of unique diversity. In their study, using 201 species, they concluded that the region has 21.9% endemism with 152 species found on the shelf (0-200m), 135 in the bathyal (200-3500m) zone, 20 in the abyssal (3500-6500m) zone and one from the Hadal (6500m+) zone. The defined region was inclusive of a portion of the Southern Ocean, including Prince Edward and Marion Islands. This accounts for their higher species richness and deep-water records, which was beyond the scope of this study, where the deepest known depth within the mainland EEZ is 5700m (Griffiths *et al.*, 2010).

The separation between shallow and deep-water species in South Africa is clear in the current data. The number of species is highest on the shelf & slope (31-500m) and in particular in the Natal ecoregion. The continental shelf is much narrower on the east coast than on the south and west coasts, thus making access to deep water easier and less costly. Despite this, the number of deep-water samples on the east coast is poor, most probably because the majority of samples from the south and west coasts came from demersal fish surveys, which are still today not undertaken on the east coast. Hence the bathyal zone (501-3500m) off the west and south coasts is fairly well represented, but not so on the east coast. Most of the historical expeditions were directed off the south coast, including the only sample collected in the abyss at 3534m, by the *Challenger* in 1873. No Ophiuroidea samples have been recorded from the abyss in over 140 years.

Four families (Asteronychidae, Asteroschematidae, Euryalidae and Amphilepididae) were exclusively deep-water in South Africa, but these families are not necessarily deep-water exclusive on a global scale. This is most probably an artefact of the Asteronychidae, Euryalidae and Amphilepididae, each represented by only a single species in South Africa and the Asteroschematidae having just two species. Stöhr *et al.* (2012) noted that the dominant families in tropical and temperate shallow-water were the Ophiotrichidae, Ophionereididae, Ophiocomidae, Ophiodermatidae, Ophiactidae and Amphiuridae, while the remaining families were deep-water dwellers. The cut off between deep- and shallow-water is largely unrefined in the literature, even within echinoderm studies. It appears that various authors have based their cut-off depths in their respective areas according to the local topography, sampling reach, or the accepted 'shallow' range at the time. Shallow has been defined at 0-10m (Thomas, 1962), 0-20m (Clark and Rowe, 1971; Rowe and Richmond, 2004); 0-30m (Samyn, 2003; Pomory, 2007); 0-40m (Jeng, 1998); 0-50m (Samyn and Thandar, 2003; Samyn, 2003; Martinez, 2008) and 0-99m (Clark and Courtman-Stock, 1976). Most of these studies used the criteria of SCUBA diving depth restrictions as the shallow-water limit. In this study 'shallow' was regarded as 0-30m, based on the broad similarities along the South African coastline, as described in Sink *et al.* (2012). This depth range is heavily influenced by light attenuation, wave action and turbulence, while the biological support for this cut-off is based on the low abundance of macro-algae below 30m, diving birds, such as penguins most frequently dive to 30m, the sardine run occurs to this depth and the majority of the coral reef communities in South Africa occur up to 30m (Lombard *et al.*, 2004). In this study, there were no exclusively shallow-water families, although the Ophiocomidae and Ophionereididae were not present in depths below 200m.

Deep-water species occupy a broader depth range than those in the inshore, corresponding to the global trend suggested by Rex *et al.* (2005) and Vanreusel *et al.* (2010). The factors driving diversity and richness in relation to depth are relatively unknown, but it is understood that these are a result of a series of complex interactions that occurred at different scales over space and time (Levin *et al.*, 2001; Stuart *et al.*, 2003; Rex *et al.*, 2005). In addition, mollusc researchers have suggested that abyssal

fauna are too sparsely distributed to sustain their own populations and were largely derived by the dispersal from bathyal depths (Rex *et al.*, 2005). Hyman (1955) reported that the Ophiuroidea, in comparison to the other echinoderm classes, have been more successful in spreading over the sea floor, most probably as a result of their smaller size, greater agility, and their secluded habits, which have given them an advantage over other extant classes of echinoderms.

Patterns of biodiversity and biogeography

Species richness

Even though the Ophiuroidea only make up 1.1% of all described marine species in South Africa (12 914: Griffiths *et al*., 2010; Costello *et al*., 2010), they comprise 28.2% of all echinoderm species in the region. Other regions with similar marine species richness, include the Caribbean (12 046; Miloslavich *et al*., 2010; Costello *et al*., 2010) and New Zealand (12 780; Gordon *et al*., 2010; Costello *et al*., 2010). In South Africa, the total seabed area is far less than the latter two regions. Figure 7.22 shows the three regions with associated seabed area, species richness per km^2 and number of Ophiuroidea per km^2. It is remarkable that although South Africa has a much smaller seabed area, the number of species and number of Ophiuroidea per km^2 is far greater than the other two regions. These three regions are vastly different, they are influenced and regulated by physical and biological processes of which account for the differences in species richness. Unlike the Caribbean and New Zealand, the South African region is seldom influenced by volcanic activity and earthquakes. The ocean currents are also quite different with the Caribbean being bounded by the coasts of Central and South America and by the Antilles island chain (Miloslavich *et al*., 2010), whereas South Africa and New Zealand are directly influenced by major oceanic currents (Griffiths *et al*., 2010; Gordon *et al*., 2010). Latitude and associated temperature regimes also account for differences in species richness with the Caribbean region at a latitude of between 21°N and 8°N, while South Africa and New Zealand are between 26°S and 37°S and 32°S and 51°S, respectively.

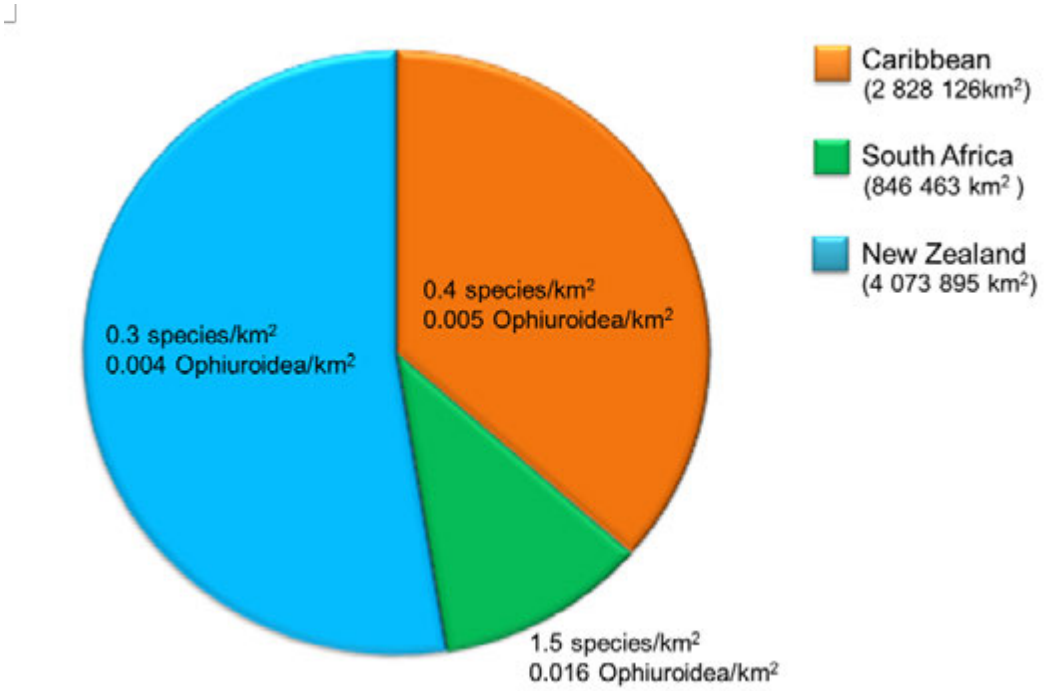

Figure 7.22. Relative size of seabed area and associated number of species and Ophiuroidea per km^2 for three regions with similar species richness. Data from Costello *et al.* (2010); Griffiths *et al.* (2010); Gordon *et al.* (2010) and Miloslavich *et al.* (2010).

In a global diversity review, Stöhr *et al.* (2012) suggested that their South African region hosts 201 Ophiuroidea species, which is moderately high in comparison to other regions at the same latitudes, i.e. South America has a lower species richness (120 species), but the south Pacific has a higher species richness (350 species). The regions in Stöhr *et al.* (2012) were delineated by latitude, longitude and bathymetry and not on species richness or diversity patterns, and it is believed that the species richness for the South African region is probably elevated because it is estimated that only an additional ~35 species would be found in the southern reaches of the zone at 60ºS, while the northern boundary of the zone excludes 150km of South Africa coastline on the west coast and 350km on the east coast. In addition, the many ecoregions within the South African region may account for the high diversity in comparison to other regions.

Patterns of sampling effort (number of records) are different to patterns of species richness. The number of records are very low in the Northern Cape and a huge peak around Cape Town then followed by another smaller peak at Sodwana Bay. Likewise, the species richness is also low in the Northern Cape with a peak in the Western Cape and the largest peak at Sodwana Bay.

Similar patterns in sampling intensity and species richness have been demonstrated by Emanuel *et al.* (1992), Gibbons *et al.* (1999), Scott (2009) and Griffiths *et al.* (2010), who point out that the peaks and biases in sampling intensity and hence species richness occur in the vicinity of major cities, towns and areas adjacent to major marine biology research centres. However, sampling intensity should not completely be disregarded, because these peaks are often associated with areas of known biogeographical breaks (Gibbons *et al.*, 1999; Bolton and Stegenga, 2002 and Acuña and Griffiths, 2004). In this study, some areas with low numbers of records are congruent with areas of restricted access, e.g. mining areas in the Northern Cape and north of Richards Bay, in harbours, and areas where access to the coast and resources for field work are limited, i.e. Transkei and in southern and northern areas of iSimangaliso Wetland Park.

Emanuel *et al.* (1992) noted that, due to mining concession areas, the Northern Cape is probably the most under-sampled yet pristine areas in South Africa, where no commercial fishing rights or public access is permitted. However, in the case of iSimangaliso, Cape Vidal, Sodwana Bay and Kosi Bay, these areas are the main entry points onto the coast and this is reflected in the data. The high number of records at Sodwana Bay is particularly noteworthy and is probably a true reflection of what the known biodiversity would be if sampling intensity was uniform throughout the iSimangaliso Marine Protected Area. Sodwana Bay is the preferred location for diving because access to resources, such as accommodation, dive boats, dive equipment and general supplies are readily available. Alternate coastal access points are minimal and the distance to travel to suitable sampling locations is often great and challenging, i.e. dirt roads, limited infrastructure, etc. In addition, iSimangaliso hosts three large no-take or sanctuary areas, where collecting and / or sampling is generally not permitted. In the last 16 years, three echinoderm diversity expeditions to these areas have been undertaken through collaboration with Belgian taxonomists. Over 725 echinoderm specimens were collected in KZN, adding 51 new species to the known KZN echinoderm fauna (Bolton *et al.*, 2001). Although a species list was never formally published (but is included in the present study), Samyn and Thandar (2003) stated that there was a 56.1% (~23 species) increase in Ophiuroidea species collected during the expeditions. This is a remarkable addition to the fauna, indicating that the area was grossly under-sampled. Similar increases were noted by Filander and Griffiths (2014) and Thandar (2015) for the Echinoidea and Holothuroidea, respectively, as a result of these expeditions.

Species richness offshore decreases with increasing distance from the coast, and this pattern is due to a drastic decline in sampling effort, although there may also be increasing uniformity of habitat in deeper waters.

Faunistic affinities and endemism

Since Clark and Courtman-Stock's (1976) monograph, Olbers and Samyn (2012) added four additional Indo-Pacific ophiuroid species to the South African fauna, while Olbers *et al.* (2015) added another 24 of which, 21 are also of Indo-Pacific origin. Both Clark and Courtman-Stock (1976) and Thandar (1989) stated that the largest component of the Ophiuroidea was represented by the endemic species, followed by the Indo-Pacific species, at 46.0% and 37.9%, respectively. Thandar (1989) further reported that 6.5% of the Ophiuroidea were Atlantic species whereas the smallest component were the tropicopolitan (1.0%), defined as those species common in the tropics of the Indian, Pacific and at least the West Atlantic Oceans (Table 7.7). In this study, the Indo-Pacific category contains the largest number of species across all depth categories and there appears to be no attrition attributed to depth or distance from the coastline.

Table 7.7. Number of species with different biogeographic affiliations in past and present Ophiuroidea studies. The category 'other' includes species found in both the Atlantic and Indian Oceans, but are not endemic or cosmopolitan, and may occur in the Southern Ocean, but not in the Pacific Ocean, North Atlantic or in the Mediterranean.

Study	Atlantic		Cosmopolitan		Indo-Pacific		Other		Endemic		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Clark and Courtman-Stock, 1976[1]	8	7.0	5	4.3	38	33.0	7	6.1	57	49.6	115
Thandar, 1989[1]	8	6.5	5	4.0	47	37.9	7	5.6	57	46.0	124
This study	9	6.6	7	5.2	69	50.8	18	13.3	33	24.1	136

[1] Studies on southern African fauna and not South Africa alone.

Thandar (1989) suggested that, given the fact that echinoderms are extraordinarily stenothermic and as a result there are only a few cosmopolitan species and when only the shelf species are considered, this cosmopolitan component would decrease to less than 1%. However, in this study the greatest number of cosmopolitan species are found in depths of 30-500m (five species) and 501-3500m (five species), suggesting that temperature alone cannot be the main criteria for explaining the distribution of Ophiuroidea in South Africa.

The number of endemic species in this study was 33 (24.1% of the fauna), which is lower than the average endemic component of all South African marine fauna recorded as 31.4% by Gibbons *et al.* (1999). In fact, Clark and Courtman-Stock (1976) recorded echinoderm (excluding Holothuroidea) endemism as 49.6% and Thandar (1989) (including Holothuroidea) as 46.0%. Gibbons *et al.* (1999) and Griffiths *et al.* (2010) (43.7%) suggested a much higher endemism for the Ophiuroidea than found in this study. Both Clark and Courtman-Stock (1976) and Thandar's (1989) calculations may be a result of their analyses being undertaken on endemic species to southern Africa and not South Africa *per se*. Nevertheless, the value given by Gibbons *et al.* (1999) is also extremely high given that their study was within the political borders of South Africa. Gibbons *et al.* (1999) however, did state that the degree of endemism should be viewed with caution, because some species that are well-studied within South Africa, are poorly known in neighbouring countries, thus inflating local endemism values. In this study, endemic species are present, within the inshore region, from the Groen River area (section 3) in the Northern Cape to Black Rock in KZN contrary to Awad *et al.* (2002) who noted that no endemic echinoderms occur north of Richards Bay. The lower percentage of endemic species found in this

study is probably a result of the large increase of Indo-Pacific species as an additional 22 Ophiuroidea species are recorded, since Thandar (1989). Filander (2014) also found this to be the case with the Echinoidea, with 26.8% endemism, as opposed to the 39.0% proposed by Thandar (1989). It should be noted again that the studies are not directly comparable, as the areas of study were slightly different.

Regional patterns of endemicity were similar to those of species richness. Although highest endemicity was found in the offshore data (27.4%), this was not significantly different from the inshore figure (20.3%). Overall, highest endemicity was found in the Natal ecoregion (25 species), followed by the Agulhas ecoregion (19 species) and the Southwest Indian ecoregion (12 species). Neighbouring countries, Namibia and Mozambique are severely under-sampled, thus elevating the endemicity in South Africa and given that endemism is related to range, it would be expected that the Agulhas ecoregion, which is furthest from political borders within South Africa, has a high endemicity, as suggested by Awad *et al.* (2002). Awad *et al.* (2002) stated that endemicity would be highest on the south coast, because it is farthest from political borders. In this study, the lowest endemism was found in the Delagoa (10 species) and Southeast Atlantic (4 species) ecoregions, similar to Awad *et al.* (2002).

The inshore depth range (0-30m) hosted 18.5% endemics, with the shelf & slope (31-500m) hosting the greatest proportion (55.2%), followed by 24.1% in the bathyal (501-3500m), suggesting that there is no trend of endemicity with depth in South Africa, as was also found for the Cirripedia (Biccard, 2013) and Actiniaria and Corallimorpharia (Laird, 2013).

Spatial patterns and diversity

The biogeographic patterns revealed by multivariate analyses were not obvious, indicating that multivariate analysis alone should not be used to compare biogeographical breaks. Species turn-over calculations were found to be an essential tool in pin-pointing variations along the coastline. The multivariate analysis showed that the Ophiuroidea occurrence data roughly corresponded to the recognised ecoregions, as demarcated by Sink *et al.* (2012). However, in the multivariate analysis, the historical biogeographical breaks (as demarcated by Stephenson and Stephenson, 1972) were the most statistically robust, with all three regions being significantly different.

Using species turnover calculations (ß-diversity; Wilson and Shmida, 1984), areas where species turnover is high in Ophiuroidea were identified and found to be in the vicinity of the Cape Peninsula, Knysna, between Great Fish River and Hluleka, which includes the Mbashe River and in the vicinity of St Lucia and Cape Vidal. With the exception of Knysna, all these areas are congruent with three main biogeographic breaks along the South African coastline, as highlighted by Stephenson and Stephenson (1972). Since then, various amendments, proposals and comparisons have been made to the biogeographic breaks and boundaries (Table 7.1). Even though some studies have shown different biogeographic breaks within their respective groups, the three historical biogeographic breaks are still the most widely accepted and certainly, in this study, outline the most obvious biogeographic regions within South Africa. Hence, the data here are compared to that of both Sink *et al.* (2012) and Stephenson and Stephenson (1972) delineations.

In the inshore, the greatest dissimilarities are found between the Agulhas and Delagoa and Southern Benguela and Delagoa ecoregions, as expected, given the vast differences in habitat, oceanography, currents and distance between these regions (Sink *et al.*, 2012). These dissimilarities can be explained by the unique taxa within each of these ecoregions, which are tropical / subtropical and temperate species. A similar, but perhaps less obvious, scenario would be expected for the Natal and Delagoa

ecoregions, given that the Natal ecoregion is in an area of overlap with warm-temperate and subtropical species (Bolton and Stegenga, 2002) while the Delagoa ecoregion is characterised by the presence of tropical and subtropical species (Bolton and Stegenga, 2002; Sink *et al.*, 2012). However, only the southern tail-end of the Delagoa ecoregion lies within South African borders and the fauna is not well-known for the entire ecoregion, which possibly extends north to Inhaca (Sink *et al.*, 2005) or Bazaruto (EAME, 2004) in Mozambique.

In terms of the clustering of the ecoregions (Figure 7.12), clusters B & D are not significantly different, which is peculiar because they lie within very different ecoregions, but do correspond to the southern portion of the Natal ecoregion and northeastern portion of the Agulhas ecoregion, in the vicinity of East London. The dissimilarity between clusters B & D, most probably lie in the number of species, which are determined by sampling effort, evident by the peaks in the number of records in all the relevant 100km sections.

In the offshore analysis, four significant Ophiuroidea assemblages were identified in Figure 7.18. In general, the clusters conformed to the ecoregions, with Cluster A corresponding mostly to the Southeast Atlantic ecoregions, with *Ophiura* (*Ophiuroglypha*) *costata costata*, *Ophiothrix (Ophiothrix) aristulata* and *Asteronyx loveni* being the dominant species. These species are all widespread deep-water species. Cluster B, corresponding to the Agulhas ecoregion, was characterised by the presence of *Astrocladus euryale*, *Ophiothrix fragilis* var. *triglochis* and *Ophiacantha nerthepsila*, all with deep-water and subtropical or tropical affinities. Cluster C was dominant in the Southeast Atlantic and Agulhas ecoregions with *Ophiothrix fragilis* var. *triglochis*, *Ophiura* (*Dictenoidea*) *anoidea* and *Ophiactis carnea* characterising the cluster, species all known to occur on the shelf and in warm temperate waters. Cluster D corresponded to the Delagoa, Natal and southwest Indian ecoregions with *Amphiura (Amphiura) grandisquama natalensis, Ophiothamnus remotus, Amphiura (Amphiura) albella* and *Ophiacantha baccata,* which all occur in both shallow and deep-waters with almost continuous distribution from west to east within South African waters. Even though, few records were present in some of the QDGC's, the findings in this study demonstrated that the dominant species conformed to global distribution trends where deep-water species have large biogeographic ranges (Stöhr *et al.* (2012)).

The distribution, depth patterns, species richness, faunistic affinity, endemicity and diversity patterns of the South African Ophiuroidea follow similar trends to other invertebrates in South Africa. Together with additional data and multiple statistical assessments, the Ophiuroidea can be a reliable group to establish biogeographic patterns for South Africa, certainly for the inshore. The sampling trends over time indicate that expeditions offshore on large vessels are becoming rare, which is compromising the data collected from deep areas within the EEZ. However, good, identifiable photographs by citizen scientists and newer technology (ROV's) will soon bring South Africa alongside many first world countries in terms of maximising technology and deep-water exploration. The Ophiuroidea contribute an important and unique component to the marine biodiversity in South Africa and as a result of this study can be used in larger analyses, especially when conservation models or spatial planning are considered.

Chapter 8: Synthesis.

The overall aims of this thesis were to revise the taxonomy, biodiversity and biogeography of the Ophiuroidea of South Africa.

The first chapter creates the framework for the study, by reviewing the current species richness of the global Echinodermata and regional Ophiuroidea. The broad morphological characteristics, significance of the jaws and differences between the families are described in detail. Technical terms are explained in a glossary, which is supplemented by illustrations of key morphological features where necessary.

Chapter 2 summarises the history of ophiuroid research in South Africa and documents additional species that have been added to the regional fauna since the last monographic guide of Clark and Courtman-Stock (1976). The history of ophiuroid research within the region since 1783 is reported, showing that for a period of 60 years, only a single species was known. The number of species slowly increased as a result of largely three European researchers (H.L. Clark, A.M. Clark and Th. Mortensen) whose work focused on South African echinoderm collections, culminating in the monograph of Clark and Courtman-Stock (1976).

Also in this chapter an additional 24 species are reported within the mainland Exclusive Economic Zone of South Africa, elevating the total known number of ophiuroid species to 136, representing more than an 18% addition to the ophiuroid fauna in the region. In addition the type material for *Amphilimna cribriformis* Clark, 1974 and *Ophionephthys lowelli* Clark, 1974 were found to be compromised and it was suggested that neotypes be designated. *Ophiernus quadrispinus* Koehler, 1908 specimens were trawled in 1959 and identified by A.M. Clark, but were not included in the Clark and Courtman-Stock (1976) monograph for unknown reasons. Later, Madsen (1977) described this species as a new record for South Africa. It is also suggested that *Amphioplus* (*Lymanella*) *hastatus* is a synonym of *Amphioplus* (*Lymanella*) *depressus* (Ljungman, 1867b).

In Chapter 3, the exclusively subtropical / tropical genus, *Ophiocoma*, is revised, raising the number of ophiocomid species recorded in South Africa from four to eight. In addition, the juvenile of *Ophiocoma (Breviturma) brevipes*, found on the underside of adult *O. brevipes*, is described in detail and a neotype for *O. scolopendrina* is designated. Although quantitative data were beyond the scope of this study, recent collections indicate that the ophiocomids dominate the abundance of ophiuroid species on the KwaZulu-Natal coast.

In Chapter 4, an orphaned collection of echinoderms housed at the Durban Natural Science Museum is described. This chapter is debatably one of the most significant and relevant to global echinoderm taxonomy. The collection includes holotypes of the South African endemic ophiuroid *Asteroschema capensis* Mortensen, 1925 [=*Asteromorpha capensis* (Mortensen, 1925) according to Okanishi *et al.*, 2013] and the South African endemic asteroid *Anthenoides marleyi* Mortensen, 1925. The holotype of the asteroid *Hacelia superba* var. *capensis* Mortensen, 1925 was not located and is considered lost, whilst the holotype of the asteroid *Anthosticte pacei* Mortensen, 1925 [=*Tethyaster pacei* (Mortensen, 1925)] is reported to be housed in the Zoological Museum Copenhagen in Denmark. The echinoid *Plococidaris verticillata* (Lamarck, 1816) is reported to be a new distribution record for South Africa. It appeared that the Durban Natural Science Museum collection had not been examined by a specialist since Mortensen (1925). As a result of this study, the collection has now been identified, accessioned and a photographic record is now available.

The holotype of *Asteroschema capensis* Mortensen, 1925 was considered lost until the rediscovery of the orphaned collection in the Durban Natural Science Museum. As a result, the genus *Asteromorpha* Lütken, 1869 is revised in Chapter 5. In addition, a new combination of *Asteroschema capensis* (Euryalidae: Asteroschematinae) is proposed. The four species of *Asteromorpha*, namely *A. capensis*, *A. koehleri*, *A. rousseaui* and *A. tenax,* are all redescribed and a taxonomic key is provided. The significance of this chapter is that it contributed to the global taxonomic revision of the genus *Asteromorpha,* even though only a single species, *Asteromorpha capensis*, is known to occur in South Africa.

One of the main products of this study is the identification guide, which is presented in Chapter 6. This is designed to be comprehensive, well-illustrated, and easy to use for both naturalists and professional biologists and to supersede the Ophiuroidea key in Clark and Courtman-Stock (1976). All South African species discovered over the last 39 years, as well as new distribution records to the region, are included.

The guide includes a taxonomic key to all 136 species, key references including authorities of both included species and accepted synonyms, distribution maps, diagnoses, scaled photographs (where possible), and a synthesis of known ecological and depth information. A checklist of all species is also included (Appendix B). Individual distribution records are plotted for each species, which has never before been undertaken for South African Ophiuroidea.

A number of species, reported for southern Africa in Clark and Courtman-Stock (1976) but not encountered in this study are listed below. As a result of the variable collecting efforts around the South African coast, it is likely that, with additional sampling, these species will be found. These species, together their authorities are listed in Table 8.1.

Table 8.1. Species recorded in southern Africa by Clark and Courtman-Stock (1976), but not recorded within the political borders of mainland South Africa.

Species
Astrobrachion constrictum (Farquhar, 1900)*
Ophiothrix (Ophiothrix) trilineata Lütken, 1869
Amphiura (*Amphiura*) *candida* Ljungman, 1867
A. (Amphiura) inhacensis Balinsky, 1957 accepted as *A. (Amphiura) dejectoides* H.L. Clark, 1939
A. (Fellaria) africana Balinsky, 1957
Ophiocentrus dilatatus (Koehler, 1905) accepted as *Ophiocentrus dilatata* (Koehler, 1905)**
Paracrocnida sacensis (Balinsky, 1957)
Ophiactis delagoa Balinsky, 1957
O. hemiteles Clark, 1915
O. modesta Brock, 1888
Ophiomastix variabilis Koehler, 1905
Ophiocirce inutilis Koehler, 1904 accepted as *Ophioleuce seminudum* Koehler, 1904

* According to Clark (1923), the holotype was found by the *Gazelle* off Spencer Bay, South West Africa. According to Mortensen (1933e), this was an error in which the co-ordinates were mistyped. This species is in fact only found off Australia and New Zealand.

** In 1957, Balinsky, stated that his record of *Ophiocentrus dilatata* was the first for the African coast.

Specimens used during this study were derived from various sampling methods, including trawling, dredging, SCUBA diving, hand-collecting, photographic records and Remotely Operated Vehicles (ROV). Over time, it was found that trawling and dredging have become less popular, while collections on SCUBA have become the most common modern collection method, with photography also

increasing in popularity. The increase in the last decade in the use of photographs to identify species has improved our knowledge of distribution data but unlike the Asteroidea and Echinoidea, many Ophiuroidea and Holothuroidea are not easy to identify using photographs. However, the value of Ophiuroidea photographs lie in the opportunity to document various size classes and colour morphologies of some species.

The distribution, depth patterns, species richness, faunistic affinity, endemicity and diversity patterns of the South African Ophiuroidea are presented in Chapter 7 and these follow similar trends to other invertebrates in South Africa. Significant range extensions for 23 species are also documented.

A clear separation between shallow-water (<30m) and deep-water (>30m) species is revealed with the deepest species (*Ophiura (Ophiuroglypha) irrorata irrorata*) recorded at 3534m. Four families (Asteronychidae, Asteroschematidae, Euryalidae and Amphilepididae) are exclusively deep-water in South Africa, but not necessarily deep-water exclusive on a global scale. No Ophiuroidea samples have been recorded in the abyss of South Africa in over 140 years, while there are no exclusively shallow-water families, although the Ophiocomidae and Ophionereididae are not present in depths below 200m.

The peaks in number of records and species generally coincided with major towns, cities, or areas with easy access to the coast. Conversely, restricted areas were found to have a low number of species and records, including prohibited mining areas in the Northern Cape and north of Richards Bay, in harbours, and areas where access to the coast and resources for field work are limited (e.g. Transkei and southern and northern areas of iSimangaliso Wetland Park). Species richness offshore decreases with increasing distance from the coast, and this pattern is due to a drastic decline in sampling effort, even though there may also be increasing uniformity of habitat in deeper waters.

The majority of species found in the region were Indo-Pacific in terms of their global distributions, followed by followed by endemic species with a few Atlantic and cosmopolitan species. Thirty-three species were endemic, but no endemic genera or families were recorded. Endemic Ophiuroidea are present around the whole coastline, from the Groen River in the Northern Cape to Black Rock in KZN, which is in contrast with Awad *et al.* (2002), who noted that no endemic echinoderms were present north of Richards Bay.

The biogeographic patterns revealed that the Ophiuroidea abundance data roughly correspond to the recognised ecoregions demarcated by Sink *et al.* (2012). However, the biogeographical breaks were statistically robust and congruent with the three main historical biogeographic breaks along the South African coastline, as defined by Stephenson and Stephenson (1972).

The nature of science is such that as answers are being sought, more questions arise. In this study, the following questions remain unanswered:

1. Hoareau *et al.* (2013) found three clades within *Ophiarachnella gorgonia*, two from the Western Indian Ocean. Based on their colour morphology, it is believed that this species is from Hoareau's lineage number two (Tim O'Hara, pers. comm.). To confirm this, the South African specimens of *O. gorgonia* would be required to be sequenced.

2. Clark and Courtman-Stock (1976) suggested that *Ophiogymna fulgens* was originally described by Koehler (1905a) as *Ophiothrix fulgens*. Subsequently *Ophiothrix fulgens* has been accepted as a synonym of *Ophiogymna pellicula* (Rowe and Gates, 1995). Therefore, *Ophiogymna fulgens* may be a synonym of *Ophiogymna pellicula* and in fact not a valid name.

Further examinations of *Ophiothrix fulgens* and *Ophiogymna fulgens* (designated by Koehler, 1922b) should be undertaken.

3. Clark and Courtman-Stock (1976) suggested that *Macrophiothrix aspidota* (Müller and Troschel, 1842) should be synonymised with *Macrophiothrix longipeda* (Lamarck, 1816) following a revision. Meanwhile, *Macrophiothrix longipeda* was recorded from Port Elizabeth in the Eastern Cape by A.M. Clark in 1968, but later it was suggested that this record was incorrect (Clark and Courtman-Stock, 1976). In this study, it was found that *Macrophiothrix longipeda* was confined to KwaZulu-Natal and it is here suggested that a revision and comparison between *Macrophiothrix aspidota* and *Macrophiothrix longipeda* be undertaken.

4. On a single specimen of *Ophiothela venusta* (RMCA MT2340; D.D. = 3mm) a smaller individual (D.D. = 1mm) was found attached to its dorsal surface (Figure 8.1). This individual appears to be morphologically identical to the larger specimen and may be a juvenile of *O. venusta.* No dwarfism, parental care or brooding has been reported for this species and therefore requires further investigation.

   In addition, morphological characters have proven unreliable to separate Indo-West Pacific and South African *Ophiothela* species and it is recommended that molecular studies be undertaken on the genus.

Figure 8.1. *Ophiothela venusta,* housed in the Royal Museum for Central Africa, with a smaller, morphologically identical individual attached, to dorsal surface (RMCA MT2340).

5. According to Hendler (1975), only 55 species of ophiuroids have been reported as viviparous, which is less than 3% of all known species. If the juveniles found attached to adult *Ophiocoma (Breviturma) brevipes* individuals during this study are indeed also *Ophiocoma (Breviturma) brevipes*, then this report is the first account of parental care in *O. brevipes*. However, based on the examined material, it is concluded that free-living juveniles of *O. brevipes* must be very rare, which is in contrast to juveniles of other ophiocomid species, such as *Ophiocoma erinaceus,* which have been found free-living (Price and Rowe, 1996). Reproductive experiments on *O. brevipes* populations from various locations within South Africa would provide better insight into its ontology and the reproductive strategy.

6. During discussions with experts, Dr Tim O'Hara stated that the South African specimens of *Ophiarachnella septemspinosa* are "very red" in comparison to the Australian red specimens and may represent a cryptic species complex. He suggested that a molecular study on this species be undertaken.

7. The high polymorphism (coloration, number of arms, shape of arm plates, radial shields, number of oral papillae and arm spines) in the South African species and the Indo-Pacific species of *Ophiactis* is astounding and a comprehensive global revision is required. This was also noted by Hendler *et al.* (1995) and Pomory (2007).

8. In this study *Ophiothrix aristulata*, *O. fragilis* and *O*. var. *triglochis* are treated as separate species, but it is recommended that they be revised to validate if this is indeed the case.

The main objective of this study was to revise the taxonomy, biodiversity and biogeography of the Ophiuroidea of South Africa. This was successfully achieved and has produced a number of products that contribute to the current state of knowledge of South Africa's marine fauna. The Ophiuroidea contribute an important and unique component to the marine biodiversity and as a result of this study, conservation and spatial planning initiatives can be updated, improved and benefit the biodiversity targets for South Africa.

In addition to the products presented here, it should be mentioned that this study was aimed to benefit more than one national department. The research and outcomes were aimed at benefiting marine research targets under the Department of Environmental Affairs. However, the Department of Arts and Culture, under which the Iziko South African Museum is placed, is severely under-funded and under-staffed. Upon inception of this study, the echinoderm collection was largely disorganised and in an effort to contribute and to benefit South Africa's natural heritage, the echinoderm material was sorted, re-shelved and re-bottled in their respective classes. In the case of the Ophiuroidea, all specimens for which taxonomic names were outdated, or had been synonymised, were updated, while the unidentified material (~400 lots), were identified, labelled and bottled appropriately.

REFERENCES

Acuña, F.H. and Griffiths, C.L. 2004. Species richness, endemicity and distribution patterns of South African sea anemones (Cnidaria: Actiniaria & Corallimorpharia). *African Zoology* **39**(2): 193-200.

Agassiz, A. 1836. Prodrome d'une monographie des Radiares ou Echinodermes. *Mémoires de la Société des Sciences Naturelles de Neuchâtel* **1**: 168-199.

Agassiz, A. 1863. List of echinoderms sent to different institutions in exchange for other specimens, with annotations. *Bulletin of the Museum of Comparative Zoology* **1**(2): 17-28.

Agassiz, A. 1872. *Revision of the Echini*. Cambridge University Press. 972pp.

Agassiz, L. 1835. Prodrome d'une monographie des Radiaire ou Echinodermes. *Mémoires Société Science Naturelles, Neuchâtel* **1**: 168-199.

Agassiz, L. 1841. *Monographies d'Échinodermes vivants et fossiles. Anatomie des échinodermes*. lère Monographie, aux frais de l'auteur. Neuchâtel. 152pp.

Agassiz, L. and Desor, E. 1846. Catalogue raisonné des familles, des genres, et des espèces de la classe des Echinodermes. *Annales des Sciences Naturelles, Troisième. Série, Zoologie* **3(6)**: 305-373.

Alva, V. and Vadon, C. 1989. Ophiuroids from the western coast of Africa (Namibia and Guinea-Bissau). *Scientia Marina* **53**(4): 827-845.

Appeltans, W., Ahyong, S.T., Anderson, G., Angel, M.V., Artois, T., Bailly, N., Bamber, R., Barber, A., Bartsch, L., Berta, A., Blazewicz-Paszkowycz, M., Bock, P., Boxshall, G., Boyko, C.B., Brandão, S.N., Bray, R.A., Bruce, N.L., Cairns, S.D., Chan, T., Cheng, L., Collins, A.G., Cribb, T., Curini-Galletti, M., Dahdouh-Guebas, F., Davies, P.J.F., Dawson, M.N., De Clerk, O., Decock, W., De Grave, S., De Voogd, N.J., Domning, D.P., Emig, C.C., Erseus, C., Eschmeyer, W., Fauchald, K., Fautin, D.G., Feist, S.W., Fransen, C.H.J.M., Furuya, H., Garcia-Alvarez, O., Gerken, S., Gibson, D., Gittenberger, A., Gofas, S., Gómez-Daglio, L., Gordon, D.P., Guiry, M.D., Hernandez, F., Hoeksema, B.W., Hopcroft, R.R., Jauma, D., Kirk, P., Koedam, N., Koenemann, S., Kolb, J.B., Kristensen, R.M., Kroh, A., Lambert, G., Lazarus, D.B., Lemaitre, R., Longshaw, M., Lowry, J., Macpherson, E., Madin, L.P., Mah, C., Mapstone, G., McLaughlin, P.A., Mees, J., Meland, K., Messing, C.G., Mills, C.E., Molodtsova, T.N., Mooi, R., Neuhaus, B., Ng, P.K.L., Nielsen, C., Norenburg, J., Opresko, D.M., Osawa, M., Paulay, G., Perrin, W., Pilger, J.F., Poore, G.C.B., Pugh, P., Read, G.B., Reimer, J.D., Rius, M., Rocha, R.M., Saiz-Salinas, J.L., Scarabino, V., Schierwater, B., Schmidt-Rhaesa, A., Schnabel, K.E., Schotte, M., Schuchert, P., Schwabe, E., Segers, H., Self-Sullivan, C., Shenkar, N., Siegel, V., Sterrer, W., Stöhr, S., Swalla, B., Tasker, M.L., Thuesen, E.V., Timm, T., Todaro, M.A., Turon, X., Tyler, S., Uetz, P., Van der Land, J., Vanhoorne, B., Van Ofwegen, L.P., Van Soest, R.W.M., Vanaverbeke, J., Walker-Smith, G., Walter, T.C., Warren, A., Williams, G.C., Wilson, S.P. and Costello, M.J. 2012. The magnitude of global marine species diversity. *Current Biology* **22**: 2189-2202.

Awad, A.A., Griffiths, C.L. and Turpie, J.K. 2002. Distribution of South African marine benthic invertebrates applied to the selection of priority conservation areas. *Diversity and Distributions* **8**: 129-145.

Baker, A.N. 1979. Some Ophiuroidea from the Tasman Sea and adjacent waters. *New Zealand Journal of Zoology* **6**: 21-51.

Baker, A.N. 1980. Euryalinid Ophiuroidea (Echinodermata) from Australia, New Zealand, and the south-west Pacific Ocean. *New Zealand Journal of Zoology* **7**: 11-83.

Balinsky, J.B. 1957. The Ophiuroidea of Inhaca Island. *Annals of the Natal Museum* **14**(1): 1-34.

Balinsky, J.B. 1969. The Echinoderms. In: *A Natural History of Inhaca Island, Mozambique*. Macnae, W. and Kalk, M. (Ed.). Witwatersrand University Press, Johannesburg: 97-156.

Barnard, K.H. 1950. Descriptive catalogue of South African decapod Crustacea (crabs and shrimps) *Annals of the South African Museum* **38**: 1-837.

Bell, F.J. 1884. Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "*Alert*", 1881-2, Echinodermata. London. 117-177 & 509-512pp.

Bell, F.J. 1888. Descriptions of four new species of ophiuroids. *Proceedings of the Scientific Meetings of the Zoological Society of London* **1888**(2): 281-284.

Bell, F.J. 1892. *Catalogue of the British Echinoderms in the British Museum (Natural History)*. British Museum, London. 197pp.

Bell, F.J. 1898. On the Actinogonidiate echinoderms collected by Mr. J. Stanley Gardiner at Funafuti and Rotuma. *Proceedings of the Zoological Society of London* **1898**: 849-850.

Bell, F.J. 1905. On the echinoderma found off the coast of South Africa: Part 3 Ophiuroidea. *Marine Investigations in South Africa* **3**: 254-260.

Bell, F.J. 1909. Report on the echinoderma (other than holothurians) collected by Mr J. Stanley Gardiner in the western parts of the Indian Ocean. *Transactions of the Linnaean Society of London: Zoology* **13**(1): 17-22.

Benavides-Serrato, M. and O'Hara, T. 2008. A new species in the *Ophiocoma erinaceus* complex from the south-west Pacific Ocean (Echinodermata; Ophiuroidea: Ophiocomidae). *Memoirs of Museum Victoria* **65**: 51-56.

Benham, W.B. 1909. Scientific results of the New Zealand government trawling expedition 1907. Echinoderma. *Records of the Canterbury Museum* **1**: 83-116.

Biccard, A. 2013. Taxonomy, systematics and biogeography of South African Cirripedia (Thoracica). MSc. Department of Biological Sciences, University of Cape Town: 178pp.

Billett, D.S.M., Bett, B.J., Evans, R., Cross, I., Tyler, P.A. and Wolff, G.A. 2013. The reproductive ecology of deep-sea ophiuroids around the Crozet plateau, southern Indian Ocean, under contrasting productivity regimes. *Deep-Sea Research II* **92**: 18-26.

Blamey, L.K. and Branch, G.M. 2009. Habitat diversity relative to wave action on rocky shores: implications for the selection of marine protected areas. *Aquatic Conservation: Marine and Freshwater Ecosystems* **19**: 645-657.

Bolton, J.J. and Anderson, R.J. 1997. Marine vegetation. In: *Vegetation of southern Africa*. Cowling, R. M., Richardson, D. M. and Pierce, S. M. (Ed.). Cambridge University Press, Cambridge: 348-370.

Bolton, J.J., Coppejans, E., Anderson, R.J., De Clerck, O., Samyn, Y., Leliaert, F. and Thandar, A.S. 2001. Biodiversity of seaweeds and echinoderms in the Western Indian Ocean. *South African Journal of Science* **97**: 453-454.

Bolton, J.J., Leliart, F., De Clerck, Anderson, R.J., Stegenga, H., Engledow, H.E. and Coppejans, E. 2004. Where is the western limit of the tropical Indian Ocean seaweed flora? An analysis of intertidal seaweed biogeography on the east coast of South Africa. *Marine Biology* **144**: 51-59.

Bolton, J.J. and Stegenga, H. 2002. Seaweed species diversity in South Africa. *South African Journal of Marine Science* **24**: 9-18.

Borges, M. and de Siqueira Campos, L. 2011. *Ophiomusium acuferum* (Ophiolepididae) and *Ophiomisidium pulchellum* (Ophiuroidea: Echinodermata), redescription based on the Brazilian specimens. *Zoologia* **28**(2): 219-225.

Borrero-Perez, G.H., Benavides-Serrato, M., Solano, O. and Navas, G.R. 2008. Brittle-stars (Echinodermata: Ophiuroidea) from the continental shelf and upper slope of the Colombian Caribbean. *Revista de Biología Tropical* **56**(Suppl. 3): 169-204.

Branch, G.H., Griffiths, C.L., Branch, M.L. and Beckley, L.E. 2010. *Two Oceans: a Guide to the Marine Life of Southern Africa*. Struik, Cape Town. 456pp.

Branch, M., Jangoux, M., Alva, V., Massin, C. and Stampanato, S. 1993. The Echinodermata of subantarctic Marion and Prince Edward Islands. *South African Journal of Antarctic Research* **23**(1/2): 37-70.

Briggs, J.C. and Bowen, B.W. 2012. A realignment of marine biogeographic provinces with particular reference to fish distributions. *Journal of Biogeography* **39**: 12-30.

Bright, K.M.F. 1937a. The South African intertidal zone and its relation to ocean currents. 2. An area on the southern part of the west coast. *Transactions of the Royal Society of South Africa* **26**: 49-65.

Bright, K.M.F. 1937b. The South African intertidal zone and its relation to ocean currents. 3. An area of the northern part of the west coast. *Transactions of the Royal Society of South Africa* **26**: 67-88.

Brock, J. 1888. Die Ophiuriden-fauna des indischen archipels. *Zeitschrift für Wissenschaftliche Zoologie* **47**(3): 465-539.

Brown, A.C. and Jarman, N. 1978. Coastal marine habitats. In: *Biogeography and Ecology of southern Africa.* Werger, M. J. A. (Ed.). The Hague: 1241–1277.

Bruguiere, J.G. 1791. *Tableau encyclopédique et méthodique des trois règnes de la nature. Contenant l'helminthologie, ou les vers infusoires, les vers intestins, les vers mollusques.* Chez Panckoucke, Paris. 180pp.

Burfield, S.T. 1924. A new species and a new variety of ophiuroid with notes on a collection of Ophiuroidea from the Sudanese Red Sea. *Annals and Magazine of Natural History* **9**(13): 144-154.

Bussarawit, S. and Rowe, F.W.E. 1985. A new species in the ophiocomid genus *Ophiocoma* (Echinodermata: Ophiuroidea) from the west coast of Thailand, Andaman Sea. *Phuket Marine Biological Centre, Research Bulletin* **35**: 1-6.

Bustamante, R.H. and Branch, G. 1996. Large scale patterns and trophic structure of southern Africa rocky shores; the roles of geographic variation and wave exposure. *Journal of Biogeography* **23**: 339-351.

Bustamante, R.H., Branch, G.M. and Eekhout, S. 1997. The influences of physical factors on the distribution and zonation patterns of South African rocky-shore communities. *South African Journal of Marine Science* **18**(1): 119-136. Doi: 10.2989/025776197784160901.

Cherbonnier, G. and Guille, A. 1978. *Faune de Madagascar*. Muséum National d'Histoire, Paris. 272pp.

Clark, A.H. 1939. Echinoderms (other than holothurians) collected on the presidential cruise of 1938. *Smithsonian Miscellaneous Collections* **98**(11): 1-18.

Clark, A.H. 1941. A new brittlestar of the genus *Ophiocomella* from Canton Island. *Journal of the Washington Academy of Sciences* **31**: 481-483.

Clark, A.H. 1952. Echinoderms from the Marshall Islands. *Proceedings of the United States National Museum* **102**(3302): 265-303.

Clark, A.H. 1954. Gulf of Mexico: Its origin, waters and marine life. Echinoderms (other than holothurians) of the Gulf of Mexico. *Fisheries Bulletin of the U.S. Fish and Wildlife Services* **55**(89): 373-379.

Clark, A.H. 1964. Description of two new species of Ophiuroidea collected during the *Snellius* expedition. *Zoologische Mededelingen* **39**: 385-390.

Clark, A.M. 1952. Some echinoderms from South Africa. *Transactions of the Royal Society of South Africa* **33**: 193-221.

Clark, A.M. 1953. A revision of the genus *Ophionereis*. *Proceedings of the Zoological Society of London* **123**: 65-94.

Clark, A.M. 1955. Echinodermata of the Gold Coast. *Journal of the West African Science Association* **1**(2): 16-56.

Clark, A.M. 1965. Japanese and other ophiuroids from the collections of the Munich Museum. *Bulletin of the British Museum (Natural History) Zoology* **13**(2): 39-71.

Clark, A.M. 1966. Notes on the family Ophiotrichidae (Ophiuroidea). *Journal of Natural History* **13**(9): 637-655.

Clark, A.M. 1967. Echinoderms from the Red Sea. Part 2: crinoids, ophiuroids, echinoids and more asteroids. *Bulletin of the Sea Fisheries Research Station Israel* **41**: 26-58.

Clark, A.M. 1968. Notes on some tropical Indo-Pacific ophiotrichids and ophiodermatids. *Bulletin of the British Museum (Natural History) Zoology* **16**(7): 277-322.

Clark, A.M. 1970. Notes on the family Amphiuridae (Ophiuroidea). *Bulletin of the British Museum (Natural History) Zoology* **19**(1): 3-81.

Clark, A.M. 1974. Notes on some echinoderms from southern Africa. *Bulletin of the British Museum (Natural History) Zoology* **26**(6): 423-487.

Clark, A.M. 1976. Tropical epizoic echinoderms and their distribution. *Micronesica* **12**: 111-117.

Clark, A.M. 1977. The South African Museum's *Meiring Naude* Cruises, Part 4. Echinoderms. *Annals of the South African Museum* **73**(6): 133-147.

Clark, A.M. 1980. Some Ophiuroidea from the Seychelles Islands and Inhaca, Mozambique. *Revue de Zoologie Africaine* **94**(3): 533-558.

Clark, A.M. 1984. Echinodermata of the Seychelles. In: *Biogeography and Ecology of the Seychelles Islands*. Stoddart, D. R. (Ed.). Dr W Junk Publishers, The Hague: 83-102.

Clark, A.M. 1989. An index of names of recent Asteroidea, part 1: Paxillosida and Notomyotida. In: *Echinoderm Studies*. Jangoux, M. and Lawrence, J. M. (Ed.). Balkema, Rotterdam. **Vol 3**: 225-347.

Clark, A.M. 1993. An index of names of recent Asteroidea, part 2: Valvatida. In: *Echinoderm Studies*. Jangoux, M. and Lawrence, J. M. (Ed.). Balkema, Rotterdam. **Vol 4**: 187-366.

Clark, A.M. 1996. An index of names of recent Asteroidea, part 3: Velatida and Spinulosida. In: *Echinoderm Studies*. Jangoux, M. and Lawrence, J. M. (Ed.). Balkema, Rotterdam. **Vol 5**: 183-250.

Clark, A.M. and Clark, A.H. 1954. A revision of the sea-stars of the Genus *Tethyaster*. *Smithsonian Miscellaneous Collections* **122**(11): 1-27.

Clark, A.M. and Courtman-Stock, J. 1976. *The Echinoderms of Southern Africa*. British Museum (Natural History), London. 277pp.

Clark, A.M. and Downey, M.E. 1992. *Starfishes of the Atlantic, Identification Guide.* Chapman & Hall. 794pp.

Clark, A.M. and Rowe, F.W.E. 1971. *Shallow-water Indo-West Pacific Echinoderms*. Pitman Press, Bath. 238 pp.

Clark, A.M. and Spencer Davis, P. 1966. Echinoderms of the Maldive Islands. *Annals and Magazine of Natural History* **13**(8): 597-612.

Clark, H.L. 1908. Some Japanese and East Indian echinoderms. *Bulletin of the Museum of Comparative Zoology* **11**(11): 279-311.

Clark, H.L. 1909. Notes on some Australian and Indo-Pacific echinoderms. *Bulletin of the Museum of Comparative Zoology* **52**(7): 109-135.

Clark, H.L. 1911. North Pacific ophiurans in the collection of the United States National Museum. *Bulletin of the United States National Museum* **75**: 1-336.

Clark, H.L. 1913. Echinoderms from lower California, with descriptions of new species. *Bulletin of the American Museum of Natural History,* **32**(8): 185-238.

Clark, H.L. 1915a. Catalogue of recent ophiurans, based on the collection of the Museum of Comparative Zoology. *Memoirs of the Museum of Comparative Zoology at Harvard College* **25**(4): 164-376.

Clark, H.L. 1915b. Some echinoderms from west Australia. *Zoological Journal of the Linnean Society* **35**(234): 229-251.

Clark, H.L. 1916. Report on the sea lilies, starfishes, brittle stars and sea urchins obtained by the F.I.S. "*Endeavour*" on the coasts of Queensland, New South Wales, Tasmania, Victoria, south Australia and western Australia. *Endeavour Research* **4**: 1-123.

Clark, H.L. 1917. Reports on the scientific results of the expedition to the tropical Pacific in charge of Alexandra Agassiz, on the U.S. fish commission streamer '*Albatross*' from August 1899 to March 1900, Commander Jefferson F. Moser U.S.N. Commanding. *Bulletin of the Museum of Comparative Zoology* **61**(12): 429-453.

Clark, H.L. 1918. Brittle-stars, new and old. *Bulletin of the Museum of Comparative Zoology, Harvard College* **62**(6): 265-338.

Clark, H.L. 1921. The echinoderm fauna of the Torres Strait: its composition and its origin. *Publications of the Carnegie Institute, Washington* **10**: 1-233.

Clark, H.L. 1923. The echinoderm fauna of South Africa. *Annals of the South African Museum* **13**(7): 221-438.

Clark, H.L. 1924. Echinoderms from the South African fisheries and marine biological survey. I. Sea-urchins (Echinoidea). *Report from the Fisheries and Marine Biological Survey Report* **4**: 1-16.

Clark, H.L. 1932. Echinodermata (other than Asteroidea) of the Great Barrier Reef Expedition, 1928-1929: Scientific Reports. In: *Great Barrier Reef Expedition, 1928-1929: Scientific Reports*. Yonge, C. M. (Ed.). Trustees of the British Museum, London. **Vol 4**: 197-239.

Clark, H.L. 1938. Echinoderms from Australia, an account of collections made in 1929 and 1932. *Memoirs of the Museum of Comparative Zoology at Harvard College* **55**: 1-727.

Clark, H.L. 1939. The John Murray expedition. Scientific reports: Ophiuroidea. *British Museum (Natural History)* **6**(2): 29-136.

Clark, H.L. 1946. The echinoderm fauna of Australia, its composition and its origin. *Publications of the Carnegie Institute, Washington* **566**: 1-565.

Clarke, K.R. and Warwick, R.M. 1994. Similarity-based testing for community pattern: the two-way layout with no replication. *Marine Biology* **118**: 167-176.

Claus, C.F.W. 1880. *Grundzüge der Zoologie*. N. G. Elwert, Marburg. 821pp.

Cockcroft, A.C., Van Zyl, D. and Hutchings, L. 2008. Large-scale changes in the spatial distribution of South African West Coast rock lobsters: an overview. *African Journal of Marine Science* **30**(1): 149-159.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northern, K.O. and Reker, J.B. 2004. *The marine habitat classification for Britain and Ireland*. Peterborough: Joint Nature Conservation Committee. 49pp.

Connor, D.W., Gilliland, P.M., Golding, N., Robinson, P., Todd, D. and Verling, E. 2006. *UK Sea Map: the mapping of seabed and water column features of UK seas.* Peterborough: Joint Nature Conservation Committee. 26pp.

Costello, M.J., Coll, M., Danovaro, R., Halpin, P., Ojaveer, H. and Miloslavich, P. 2010. A census of marine biodiversity knowledge, resources and future challenges. *Plos One* **5**(8): e12110. Doi: e12110/10.1371/journal.pone.0012110.

Cowles, R.P. 1910. Stimuli produced by light and by contact with solid walls as factors in the behaviour of ophiuroids. *Journal of Experimental Zoology* **9**: 387-416.

Dahm, C. 1999. Ophiuroids (Echinodermata) of southern Chile and the Antarctic: taxonomy, biomass, diet and growth of dominant species. *Scientia Marina* **63**(suppl. 1): 427-432.

Dartnall, A.J. 1971. Australian sea-stars of the genus *Patiriella* (Asteroidea: Asterinidae). *Proceedings of the Linnean Society of New South Wales* **96**(1): 39-49.

Day, J.H. 1959. The biology of Langebaan Lagoon. *Transactions of the Royal Society of South Africa* **35**: 475-547.

Day, J.H. 1967a. *A Monograph on the Polychaeta of southern Africa, Part 1: Errantia*. Trustees of the British Museum (Natural History), London. 498pp.

Day, J.H. 1967b. *A Monograph on the Polychaeta of southern Africa, Part 2: Sedentaria*. Trustees of the British Museum (Natural History), London. 450pp.

Day, J.H. 1969. *A Guide to Marine Life on South African Shores*. A.A. Balkema, Cape Town. 300pp.

Day, J.H. 1974. The ecology of Morrumbene Estuary, Mozambique. *Transactions of the Royal Society of South Africa* **41**(1): 43-97.

Day, J.H., Field, J.G. and Penrith, M.J. 1970. The benthic fauna and fishes of False Bay, South Africa. *Transactions of the Royal Society of South Africa* **39**(1): 1-108.

Day, J.H., Millard, N.A.H. and Harrison, A.D. 1952. The ecology of South African estuaries. 3. Knysna: a clear open estuary. *Transactions of the Royal Society of South Africa* **33**: 367-413.

Day, J.H. and Morgans, J.F.C. 1956. The ecology of South African estuaries. The biology of Durban Bay. *Annals of the Natal Museum* **13**(3): 259-300.

De Blainville, H.M. 1825. *Oursins. In: Dictionnaire des sciences Naturelles, dans lequel on traitre méthodiquement des differéns êtres de la nature, considérés soit en eux-mêmes, d'après l'état actuel de nos connoissances, soit relativement a l'utlité qu'en peuvent retirer la médicine, l'agriculture, le commerce et les arts*. Le Normat, Paris. 59-102pp.

De Blainville, H.M. 1830. *Zoophytes. In: Dictionnaire des sciences Naturelles, dans lequel on traitre méthodiquement des differéns êtres de la nature, considérés soit en eux-mêmes, d'après l'état actuel de nos connoissances, soit relativement a l'utlité qu'en peuvent retirer la médicine, l'agriculture, le commerce et les arts*. Le Normat, Paris. 548pp.

De Castro Manso, C. 2010. Deep-water Ophiuroidea (Echinodermata) from off Chile in the eastern south Pacific. *Biota Neotropica* **10**(2): http://www.biotaneotropica.org.br/v10n2/pt/abstract?inventory+bn00810022010.

De Loriol, P. 1893a. Catalogue raisonné des Echinodermes recueillies par M. V de Robillard à l'île Maurice III. Ophiurides et Astrophytides. *Memoires de la Société de Physique et D'Histoire Naturelle de Genève* **32**(3): 1-63.

De Loriol, P. 1893b. Echinodermes de la Baie d'Amboine. *Revue Suisse de Zoologie* **1**: 359-426.

De Loriol, P. 1899. Notes pour servir a l'histoire des Echinodermes. VII. *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève* **33**: 1-34.

De Loriol, P. 1900. Notes pour servir à l'étude des Echinodermes. *Revue Suisse de Zoologie* **8**: 55-96.

Deheyn, D. and Jangoux, M. 1999. Colour varieties as sibling species in the polychromatic ophiuroid *Amphipholis squamata* (Echinodermata): evidence from inheritance of body colour and luminescence. *Journal of Experimental Marine Biology and Ecology* **234**: 219-234.

Delle Chiaje, S. 1828. *Memorie sulla storia e notomia degli animali senza vertebre del regno di Napoli.* Fratelli Fernandes and Società Tipografica, Napoli. 232pp.

Devaney, D.M. 1968. The systematics and post-larval growth changes in ophiocomid brittlestars. PhD. Department of Zoology, University of Hawaii: 343pp.

Devaney, D.M. 1970. Studies on Ophiocomidae brittle stars. I. A new genus (*Clarkcoma*) of Ophiocominae with a re-evaluation of the genus *Ophiocoma*. *Smithsonian Contributions to Zoology* **51**: 1-41.

Devaney, D.M. 1974. Shallow-water asterozoans of southeastern Polynesia. II. Ophiuroidea. *Micronesica* **10**(1): 105-204.

Devaney, D.M. 1977. *Ophiomastix koehleri*, a new ophiocomid brittlestar (Echinodermata: Ophiuroidea) from the Western Indian Ocean. *Proceedings of the Biological Society of Washington* **90**: 274-283.

Devaney, D.M. 1978. A review of the genus *Ophiomastix* (Ophiuroidea: Ophiocomidae). *Micronesica* **14**(2): 273-359.

Djakonov, A.M. 1930. Echiniden, ophiuriden und asteriden gesammelt von Prof. P.J. Schmidt bei den Riu-Kiu Inseln im Jahre 1926-1927. *Zoologische Jahrbücher* **59**: 233-252.

Döderlein, L. 1888. Echinoderme von Ceylon. Bericht über die von den Herren Dres. Sarasingesammelten Asteroidea, Ophiuroidea und Echinoidea. *Zoologische Jahrbücher* **3**: 822-846.

Döderlein, L. 1896. Bericht über die von Herrn Professor Semon bei Amboina und Thursday Island gesammelten Ophiuroidea. *Denkschriften medizinisch-naturwissenschaftliche Gesellschaft Jena* **8**: 279-300.

Döderlein, L. 1898. Über einige epizoisch lebende Ophiuroidea. *Denkschriften medizinisch-naturwissenschaftliche Gesellschaft Jena* **8**: 483-488.

Döderlein, L. 1910. Asteroidea, Ophiuroidea, Echinodea. In: *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen S dafrika: ausgef hrt in den Jahren 1903-1905 mit Unterst tzung der Kgl. Preussischen Akademie der Wissenschaften zu Berlin.* Schultz, L. (Ed.), Berlin: 245-258.

Döderlein, L. 1911. Über japanische und andere Euryalae. *Abhandlungen der Bayerischen Akademie der Wissenschaften, Mathematisch-physikalische Klasse.* **Suppl. 5**(2): 1-123.

Döderlein, L. 1917. *Die Asteriden der Siboga Expedition. 1. Die Gattung Astropecten und ihre Stammesgeschichte*. 190pp.

Döderlein, L. 1926. Über Asteriden aus dem Museum von Stockholm. *Kungliga Svenska Vetenskapsakademien Handlingar* **3**(2): 1-22.

Döderlein, L. 1927. Indopacifische Euryalae. *Abhandlungen der Bayerischen Akademie der Wissenschaften, Matematisch-Naturwissenschaftliche Abteilung* **31**(6): 105.

Döderlein, L. 1930. Die Ophiuroiden der Deutschen Tiefsee-Expedition. 2. Euryale. *Deutsche Tiefsee-Expedition 1898–1899* **22**(6): 349-396.

Downey, M.E. 1969. *Catalogue of recent ophiuroid type specimens in major collections in the United States*. Smithsonian Institution Press, Washington DC. 239pp.

Duncan, P.M. 1879. On some Ophiuroidea from the Korean Seas. *Journal of the Linnean Society of London, Zoology* **14**(77): 445-482.

Duncan, P.M. 1887. On the Ophiuridae of the Mergui Archipelago, collected for the trustees of the Indian Museum, Calcutta, by Dr John Anderson, F.R.S., Superintendent of the Museum. *Linnean Society Journal of Zoology* **21**: 85-106.

EAME 2004. *East African Marine Ecoregion Programme: The Eastern African Marine Ecoregion Biodiversity Conservation Strategic Framework 2005 – 2025*. Dar es Salaam, Tanzania. 54pp.

Ekman, S. 1953. *Zoogeography of the Sea*. Hely Thom Limited, Dublin. 215pp.

Ely, C.A. 1942. Shallow-water Asteroidea and Ophiuroidea of Hawaii. *Bernice P. Bishop Museum Bulletin* **176**: 1-63.

Emanuel, B.P., Bustamante, R.H., Branch, G.M., Eekhout, S. and Odendaal, F.J. 1992. A zoogeographic and functional approach to the selection of marine reserves on the west coast of South Africa. *South African Journal of Marine Science* **12**: 341-354.

Endean, R. 1957. The biogeography of Queensland's shallow-water echinoderm fauna (excluding Crinoidea), with a rearrangement of the faunistic provinces of tropical Australia. *Australian Journal of Marine and Freshwater Research* **8**(3): 233-273.

Engel, H. 1949. *Ophioteresis beauforti* nov. sp. *Bijdragen tot de Dierkunde* **28**: 140-143.

Eyre, J. 1939. The South African intertidal zone and its relation to ocean currents. 7. An area in False Bay. *Annals of the Natal Museum* **9**(2): 283-307.

Eyre, J., Broekhuysen, G.J. and Crichton, M.I. 1938. The South African intertidal zone and its relation to ocean currents. 6. The East London district. *Annals of the Natal Museum* **9**(1): 83-111.

Eyre, J. and Stephenson, T.A. 1938. The South African intertidal zone and its relation to ocean currents. 5. A subtropical Indian Ocean shore. *Annals of the Natal Museum* **9**(1): 21-46.

Farquhar, H. 1897. A contribution to the history of New Zealand Echinoderms. *Zoological Journal of the Linnean Society* **26**: 186-198.

Farquhar, H. 1900. On a new species of Ophiuroidea. *Transaction of the New Zealand Institute* **32**(51): 405-406.

Felder, D.L. and Camp, D.K. 2015. Gulf of Mexico – origins, waters and biota. http://gulfbase.org/biogomx.

Fell, H.B. 1952. Echinoderms from southern New Zealand. *Zoology Publications from Victoria University of Wellington* **18**: 1-37.

Fell, H.B. 1958. Deep-sea echinoderms of New Zealand. *Zoology Publications from Victoria University of Wellington* **24**: 1-40.

Fell, H.B. 1960. Synoptic keys to the genera of Ophiuroidea. *Zoology Publications from Victoria University of Wellington* **26**: 44pp.

Fell, H.B. 1962. A revision of the major genera of amphiurid Ophiuroidea. *Transactions of the Royal Society of New Zealand* **2**(1): 1-26.

Field, J.G. and Griffiths, C.L. 1991. Littoral and sublittoral ecosystems of southern Africa. In: *Ecosystems of the World*. Mathieson, A. C. and Nienhus, P. H. (Ed.). Elsevier, Amsterdam: 323-346.

Filander, Z. 2014. Taxonomy, systematics and biogeography of South African Echinoidea (Echinodermata). MSc. Department of Biological Sciences, University of Cape Town: 255pp.

Filander, Z. and Griffiths, C.L. 2014. Additions to and revision of the South African echinoid fauna (Echinodermata: Echinoidea). *African Natural History* **10**: 47-56.

Forbes, E. 1841. *A History of British Starfishes and other Animals of the Class Echinodermata*. John van Voorst, London. 320pp.

Forbes, E. 1843. On the radiata of the eastern Mediterranean. *Transactions of the Linnaean Society of London: Zoology* **19**: 143-152.

Forbes, E. 1856. Map of the distribution of marine life: The physical atlas of natural phenomena. W & A.K. Johnston, Philadelphia.

Fourgon, D., Jangoux, M. and Eeckhaut, I. 2007. Biology of a 'babysitting' symbiosis in brittle stars: analysis of the interactions between *Ophiomastix venosa* and *Ophiocoma scolopendrina*. *Invertebrate Biology* **126**(4): 385-395.

Franklin, A.M. and O'Hara, T.D. 2008. A new species in the genus *Ophiomyxa* from south-west Australian waters (Echinodermata: Ophiuroidea: Ophiomyxidae). *Memoirs of Museum Victoria* **65**: 57-62.

Franschetti, S., Terlizzi, A. and Benedetti-cecchi, L. 2005. Patterns of distribution of marine assemblages from rocky shores: evidence of relevant scales of variation. *Marine Ecology Progress Series* **296**: 13-29.

Gage, J.D., Pearson, M., Clark, A.M., Paterson, G.L.J. and Tyler, P.A. 1983. Echinoderms of the Rockall Trough and adjacent areas. 1. Crinoidea, Asteroidea and Ophiuroidea. *Bulletin of the British Museum (Natural History) Zoology* **43**(5): 263-308.

Garcia-Diez, C., Porteiro, F.M., Meirinho, A., Cardigos, F. and Tempera, F. 2005. Taxonomic review of selected invertebrate groups collected during the campaigns of the Prince Albert I of Monaco in the Azorean Waters. *Arquipelago. Life and Marine Sciences* **22A**: 35-59.

Gibbons, M.J., Abiahy, B.B., Angel, M.V., Assuncao, C.M.L., Bartsch, I., Best, P.B., Biseswar, R., Bouillon, J., Bradford-Grieve, J.M., Branch, W., Burreson, E., Cannon, L., Casanova, J.-P., Channing, A., Child, C.A., Compagno, L.J.V., Cornelius, P.F.S., Dadon, J.R., David, J.H.M., Day, J.H., Della Croce, N., Emschermann, P., Erseus, C., Esnal, G., Gibson, R., Griffiths, C.L., Hayward, P.J., Heard, R., Heemstra, P., Herbert, D.G., Hessler, R.R., Higgins, R., Hiller, N., Hirano, Y.M., Kensley, B., Kilburn, R.N., Kornicker, L., Lambshead, J., Manning, R., Marshall, D.J., Mianzan, H., Monniot, C., Newman, W., Nielsen, C., Patterson, G., Pugh, P., Roeleveld, M., Ross, A., Ryan, P.G., Ryland, J.S., Samaai, T., Schleyer, M.H., Schockaert, E., Seapy, R.R., Shiel, R., Sluys, R., Southward, E.C., Sulaiman, A., Thandar, A.S., van der Spoel, S., Van Soest, R.W.M., Van der Land, J., Vetter, E., Vinogradov, G.A.N., Williams, G.C. and Wooldridge, T. 1999. The taxonomic richness of South Africa's marine fauna: a crisis at hand. *South African Journal of Science* **95**: 8-12.

Gibbons, M.J., Barange, M. and Hutchings, L. 1995. The zoogeography and diversity of euphausiids around southern Africa. *Marine Biology* **123**: 257-268.

Gibbs, P.E., Clark, A.M. and Clark, C.M. 1976. Echinoderms from the northern region of the Great Barrier Reef, Australia. *Bulletin of the British Museum (Natural History) Zoology* **30**(4): 101-144.

Gordon, D.P., Beaumont, J., Macdiarmid, A., Robertson, D.A. and Ahyong, S.T. 2010. Marine biodiversity of *Aotearoa* New Zealand *Plos One* **5**(8): e10905. doi:10.1371/journal.pone.0010905.

Gray, J.E. 1825. An attempt to divide the Echinida or sea eggs into natural families. *Annals of Philosophy* **10**: 423-431.

Gray, J.E. 1840a. *Synopsis of the Contents of the British Museum*. British Museum, London. 370pp.

Gray, J.E. 1840b. A synopsis of the genera and species of the class Hypostoma (*Asterias* Linnaeus). *Annals of the Magazine of Natural History* **6**: 175-184.

Gray, J.E. 1847. Descriptions of some new genera and species of Asteriadae. *Proceedings of the Zoological Society of London* **12**: 72-83.

Gray, J.E. 1855. An arrangement of the families of Echinida, with description of some new genera and species. *Proceedings of the Zoological Society of London* **1855**: 35-39.

Griffiths, C.L., Robinson, T.B., Lange, L. and Mead, A. 2010. Marine biodiversity in South Africa: An evaluation of current states of knowledge. *Plos One* **5**(8): e12008. doi:10.1371/journal. pone.0012008.

Grindley, J.R. and Kensley, B.F. 1966. Benthonic marine fauna obtained off the Orange River mouth by the diamond dredger Emerson-K. *Cimbebasia* **16**: 1-14.

Grube, A.E. 1857. Diagnosen einiger neuen Echinodermen. *Archiv für Naturgeschichte*: 340-344.

Grube, A.E. 1868. Über einige seltenere oder neue Ophiuriden. *Fünfundvierzigster Jahres-Berichte und Abhandlungen der Schlesischen Gesellschaft für vaterländische Cultur* **45**: 44-45.

Guille, A. 1982. A new genus and species of ophiacanthid brittlestar (Echinodermata: Ophiuroidea) from the Kerguelen Islands, with new taxonomic, biogeographic and quantitative data on the echinoderm fauna. *Memoirs of the Australia Museum* **16**(5): 67-87.

Guille, A., Laboute, P. and Menou, J.L. 1986. Guide des etoiles de mer, oursins et autre echinoderms du lagoon de Nouvelle-Caledonie. *Faune Tropicale* **25**: 1-238.

Guille, A. and Vadon, C. 1985. Les Ophiures littorales de Nouvelle-Calédonie. *Bulletin Muséum National d'Histoire Naturelle* **7**(1): 61-72.

Guille, A. and Vadon, C. 1986. Ophiuridae de l'oceán Indien profond. *Indo-Malayan Zoology* **3**: 167-188.

Guille, A. and Wolff, W.J. 1984. Résultats biologiques de l'expédition *Snellius*. Echinodermata: Ophiuroidea. *Zoologische Verhandelingen* **213**: 3-39.

Gutt, J., Helsen, E., Arntz, W. and Buschmann, A. 1999. Biodiversity and community structure of the mega-epibenthos in the Magellan region (South America). *Scientia Marina* **63**(suppl.1): 155-170.

Harris, L., Nel, R. and Schoeman, D.S. 2011. Mapping beach morphodynamics remotely: a novel application tested on South African sandy shores. *Estuarine, Coastal and Shelf Science* **92**: 78-89.

Harrison, T.D. 2002. Preliminary assessment of the biogeography of fishes in South African estuaries. *Marine and Freshwater Research* **53**: 479-490.

Hendler, G. 1975. Adaptational significance of patterns of ophiuroid development. *American Zoologist* **15**(3): 691-715.

Hendler, G. 1984. Brittlestar colour change and phototaxis (Echinodermata: Ophiuroidea: Ophiocomidae). *Marine Ecology* **5**(4): 379-401.

Hendler, G., Migotto, A.E., Ventura, C.R.R. and Wilk, L. 2012. Epizoic *Ophiothela* brittle stars have invaded the Atlantic. *Coral Reefs* **31**(4) doi: 10.1007/s00338-012-0936-6.

Hendler, G., Miller, J.E., Pawson, D.L. and Kier, P.M. 1995. *Sea Stars, Sea Urchins and Allies: Echinoderms of Florida and the Caribbean*. Smithsonian Institution Press, Washington and London. 390pp.

Hernández-Herrejón, L.A., Solis-Marin, F.A. and Languarda-Figueras, A. 2008. Ofiuroideos (Echinodermata: Ophiuroidea) de las aguas mexicanas de golfo de Mexico. *International Journal of Tropical Biology* **56**(Suppl. 3): 83-167.

Hertz, M. 1927a. Die Ophiuriden der Deutschen Tiefsee-Expedition. I. Chilophiurida Matsumoto (Ophiolepididae, Ophioleucidae, Ophiodermatidae, Ophiocomidae). *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer Valdivia (1898-1899)* **22**: 59-122.

Hertz, M. 1927b. Die Ophiuroiden der Deutschen Südpolar-Expedition. *Deutsche Südpolar-Expedition 1901-1903, 19. Zoologie* **11**: 1-54.

Hickman, C.P. 1998. *A Field Guide to Sea Stars and other Echinoderms of Galapagos*. Sugar Spring Press, Virginia. 83pp.

Hoareau, T.B., Boissin, E., Paulay, G. and Bruggemann, J.H. 2013. The south-western Indian Ocean as a potential marine evolutionary hotspot: perspectives from comparative phylogeography of reef brittle stars. *Journal of Biogeography* **40**(11): 2167-2179.

Hoffman, C.K. 1874. Crustacés et Echinodermes de Madagascar et de l'Ile de la Réunion. In: *Recherches sur la faune de Madagascar et de ses dépendances*. Pollen, F. P. L. and Van Dam, D. C. (Ed.), Leyden. **5**: 1-58.

Hoggett, A.K. 1991. The genus *Macrophiothrix* (Ophiuroidea: Ophiotrichidae). *Invertebrate Taxonomy* **4**: 1077-1146.

Hoggett, A.K. and Rowe, F.W.E. 1986. South-west Pacific echinoids (Echinodermata), including two species. *Indo-Malayan Zoology* **3**: 1-13.

Hommersand, M.H. 1986. The biogeography of the South African marine red algae: A model. *Botanica Marina* **29**: 257-270.

Howell, K.L., Davies, J.S. and Narayanaswamy, B.E. 2010. Identifying deep-sea megafaunal epibenthic assemblages for use in habitat mapping and marine protected area network design. *Journal of the Marine Biological Association of the United Kingdom* **90**: 33-68.

Hughes, R.N. and Gamble, J.C. 1977. A quantitative survey of the biota of intertidal soft substrata on Aldabra Atoll, Indian Ocean. *Philosophical Transactions of the Royal Society B* **279**: 327-355.

Humpreys, W.F. 1981. *The Echinoderms of Kenya's Marine Parks and Adjacent Regions*. Royal Museum of Central Africa, Tervuren, Belgium. 39pp.

Hyman, L.H. 1955. *The Invertebrates: Echinodermata, The Coelomate Bilateria*. McGraw-Hill, New York. 763pp.

Imaoka, T., Irimura, S., Okutani, T., Oguro, C., Oji, T. and Kanazawa, K. 1991. *Echinoderms of the Continental Shelf and Slope around Japan: Volume 2*. Tokyo. 184pp.

Imaoka, T., Irimura, S., Okutani, T., Oguro, C., Oji, T., Shigei, M. and Horikawa, H. 1990. *Echinoderms of the continental shelf and slope around Japan: Volume 1*. Tokyo. 138pp.

Irimura, S. 1979. Ophiuroidea of Sado Island, the sea of Japan. *Annual report of the Sado Marine Biological Station* **9**: 1-6.

Irimura, S. 1981. Ophiurans from Tanabe Bay and its vicinity, with the description of a new species of *Ophiocentrus*. *Publications from the Seto Marine Biological Laboratory* **26**: 15-49.

Irimura, S. 1982. *The Brittle-stars of Sagami Bay*. Biological Laboratory Imperial Household, Japan. 95pp.

Jackson, R.T. 1912. A phylogeny of the *Echini* with a revision of palaeozoic species. *Memoirs of the Boston Society of Natural History* **7**: 318.

James, D.B. 1970. Studies on Indian echinoderms. 4: On the brittle stars *Amphioplus gravelyi* sp. nov., and *Amphioplus depressus* (Ljungman) from the Indian coasts. *Journal of the Marine Biological Association of India* **12**: 139-145.

James, D.B. 1981. Studies on Indian echinoderms - 8. On a new genus *Ophioelegans* (Ophiuroidea: Ophiuridae) with notes on *Ophiolepis superba* H.L. Clark, 1938. *Journal of the Marine Biological Association of India* **23**: 15-18.

James, D.B. 1982. Studies on Indian Echinoderms. 10: *Ophiocoma anaglyptica* (Ophiuroidea: Ophiocomidae), a new record from the Indian Ocean with notes on other species of *Ophiocoma* from Indian Seas. *Journal of the Marine Biological Association of India* **24**(1/2): 36-41.

Jangoux, M. 1985. *Catalogue commenté des types d'Echinodermes actuels conservés dans les collections nationales suisse, suivi d'une notice sur la contribution de Jean-Louis Hardouin-Michelin à la connaissance des échinodermes actuel*. Muséum d'Histoire Naturelle, Genève. 67pp.

Jeng, M. 1998. Shallow-water echinoderms of Taiping Island in the south China Sea. *Zoological Studies* **37**(2): 137-153.

Kalk, M. 1958. Ecological studies on the shores of Mozambique. The fauna of intertidal rocks at Inhaca Island, Delagoa Bay. *Annals of the Natal Museum* **14**(2): 189-242.

Kensley, B. 1978. *Guide to the Marine Isopods of southern Africa*. Trustees of the South African Museum, Cape Town. 173pp.

Kensley, B. 1981. On the zoogeography of southern African decapod Crustacea, with a distributional checklist of the species. *Smithsonian Contributions to Zoology* **338**: 1-64.

Klein, J.T. 1734. *Naturalis dispositio echinodermatum. Accessit lucubratiuncula de aculeis echinorum marinorum, cum spicilegio de belemnitis*. London. 78pp.

Koehler, R. 1895. Dragages profonds exécutés a bord du Caudan dans le Golfe de Gascogne. Rapport préliminaire sur le Échinodermes. *Revue biologique du Nord de la France* **7**: 439-496.

Koehler, R. 1896a. Note préliminaire sur les Ophiures des premieres campagnes de la "*Princesse Alice*". *Mémoires de la Société Zoologique de France* **9**: 241-253.

Koehler, R. 1896b. Note préliminaire sur les Ophiures recueillies pendant les campagnes de "L' *Hirondelle*". *Mémoires de la Société Zoologique de France* **9**: 203-213.

Koehler, R. 1897. Échinodermes recueilles par *l' investigator* dans l' Océan Indian. *Annals des Sciences Naturelles* **8**(2): 277-372.

Koehler, R. 1898a. Échinides et ophiures provenant des campagnes du yacht *L'Hirondelle* (Golfe de Gascogne, Terre-Neuve, Acores). *Résultats des Campagnes Scientifiques accomplies sur son yacht par Albert I, Prince Soverain de Monaco* **12**: 1-78.

Koehler, R. 1898b. Échinoderms recueillis par l'Investigator dans l'Océan Indien, II les Ophiures littorales. *Bulletin Scientifique de la France et de la Belgique* **31**: 55-126.

Koehler, R. 1899. An account of the deep-sea Ophiuroidea collected by the Royal Indian Marine Survey Ship *Investigator*. I. Les Ophiures de mer profonde. Indian Museum. Calcutta, India. 76pp.

Koehler, R. 1900. Echinodermes recueillis par l'Investigator dans l'Océan Indien. Les ophiures littorales. *Bulletin Scientifique de la France et de la Belgique* **31**: 55-124.

Koehler, R. 1904a. Ophiures de l'expédition du Siboga. Part 1. Ophiures de mer profonde. *Siboga Expedition Monographs* **45a**: 1-176.

Koehler, R. 1904b. Ophiures nouvelles ou peu connues. *Mémoirs Société Zoologique de France* **17**: 54-119.

Koehler, R. 1905a. Ophiures de l'expédition du Siboga. Part 2. Ophiures littorales. *Siboga Expedition Monographs* **45b**: 1-142.

Koehler, R. 1905b. *Ophiures de l'expedition Siboga: Ophiures littorales*. Librairie et imprimerie ci-devant E. J. Brill, Leide. 234pp.

Koehler, R. 1906. Description des ophiures nouvelles recueillies par le *Travailleur* et *Talisman* pendant les campagnes de 1880, 1881, 1882 et 1883. *Mémoires de la Société Zoologique de France* **19**: 5-35.

Koehler, R. 1907. Revision de la collection des ophiures du Muséum d'Histoire Naturelle de Paris. *Bulletin Scientifique de la France et de la Belgique* **41**: 279-351.

Koehler, R. 1908a. Astéries, Ophiures et Échinides de l'Expédition Antarctique National Écossaise. *Transactions of the Royal Society of Edinburgh* **46**(3): 529-649.

Koehler, R. 1908b. Astéries, ophiures et échinides recueillis dans les mers australes par la "*Scotia*" (1902-1905). *Zoologischer Anzeiger* **32**(6): 140-147.

Koehler, R. 1909a. An account of the deep-sea Asteroidea collected by the Royal Indian Marine Survey Ship *Investigator*. I. Les Astéries de Mer profonde. Indian Museum. Calcutta, India. 137pp.

Koehler, R. 1909b. Échinodermes provenant de campagnes du yacht *Princesse-Alice* (Astéries, Ophiures, Échinides et Crinoïdes). *Résultats Campagnes Scientifiques accomplies sur son yacht par Albert I, Prince Soverain de Monaco* **34**: 1-317.

Koehler, R. 1911. Mission gruvel sur la côte occidentale d'Afrique (1909-10). Échinodermes. *Annales de l'Institut océanographique* **2**(5): 1-29.

Koehler, R. 1914a. A contribution to the study of ophiurans of the United States National Museum. Smithsonian Institution, United States National Museum. 173pp.

Koehler, R. 1914b. Echinoderma. I. Asteroidea. Ophiuridea et Echinoidea. *Beiträge zur Kenntnis der Meeresfauna Westafrika* **1**(2): 128-303.

Koehler, R. 1915. Description d'une nouvelle espéce d'*Astrophiura*, l'*Astrophiura Cavellæ*. *Bulletin de l'Institut océanographique de Monaco* **311**: 1-15.

Koehler, R. 1922a. Echinodermata: Ophiuroidea. *Scientific Reports of the Australian Antarctic Expedition 1911-1914 under the leadership of Sir Douglas Mawson* **8**(2): 1-98.

Koehler, R. 1922b. Ophiurians of the Philippine seas and adjacent waters. *Bulletin of the United States National Museum* **100**(5): 597.

Koehler, R. 1923. Sur quelques Ophiures des Côtes de l'Angola et du Cap. *Meddelanden från Göteborgs Musei Zoologiska Avdelning* **18**: 1-17.

Koehler, R. 1926. Révision de quelques ophiures de Ljungman, appartenant au Musée d'Histoire Naturelle de Stockholm. *Arkiv för Zoologi Stockholm* **19A**(2): 1-29.

Koehler, R. 1927. Ophiures recueillies aux Iles Gilbert, Marshall et Fiji. *Meddelanden från Göteborgs musei zoologiska avdelning* **43**: 1-13.

Koehler, R. 1930. Ophiures recueillies par le Docteur Th. Mortensen dans les Mers d'Australie et dans l'Archipel Malais. *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i København* **89**: 1-295.

Kroh, A. and Mooi, R. 2013. World Echinoidea Database http://www.marinespecies.org/echinoidea/aphia.php?p=taxdetails&id=513478. Accessed: 19 September 2013.

Kroh, A. and Smith, A.B. 2010. The phylogeny and classification of post-palaeozoic echinoids. *Journal of Systematic Palaeontology* **8**(2): 147-212.

Laguarda-Figueras, A., Hernández-Herrejón, L.A., Solís-Marín, F.A. and Durán-González, A. 2009. *Ofiuroideos del Caribe Mexicano y Golfo de México*. CONABIO & Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Mexico City. 249pp.

Laird, M.C. 2013. Taxonomy, systematics and biogeography of South African Actiniaria and Corallimorpharia. PhD. Department of Zoology, University of Cape Town: 367pp.

Lamarck, J.B. 1801. *Systême des Animaux sans vertébres, ou tableau général des classes, des ordres et des genres de ces animaux; Présentant leurs caractères essentiels et leur distribution, d'après la considération de leurs rapports naturels et de leur organisation, et suivant l'arrangement établi dans les galeries du Muséum d'Historie Naturelle, parmi leurs dépouilles conservées. Précédé du discours d'ouverture du Cours de Zoologie, donné dans le Muséum National d'Histoire Naturelle l'an de la République*. Paris, Detreville. 432pp.

Lamarck, J.B. 1816. Les Stellérides. *Histoire Naturelle des Animaux sans Vertèbres* **2**: 528-568.

Landschoff, J. 2014. Brooding behaviour in *Ophioderma wahlbergii,* a shallow-water brittle star from South Africa. MSc. Department of Biological Sciences, University of Cape Town: 87pp.

Landschoff, J., Du Plessis, A. and Griffiths, C.L. 2015. A dataset describing brooding in three species of South African brittle stars, comprising seven high-resolution, micro X-ray computed tomography scans. *GigaScience* **4**(52): doi 10.1186/s13742-015-0093-2.

Landschoff, J. and Griffiths, C.L. 2015. Brooding behaviour in the shallow-water brittle star *Ophioderma wahlbergii*. *Invertebrate Biology* **134**(2): 168-179.

Lane, D.J.W., Marsh, L.M., VandenSpiegel, D. and Rowe, F.W.E. 2000. Echinoderm fauna of the south China Sea: An inventory and analysis of distribution patterns. *The Raffles Bulletin of Zoology* **Suppl. 8**: 459-493.

Leach, W.E. 1815. *The Zoological Miscellany: Being Descriptions of New or Interesting Animals. Vol. 2.* R.P. Nodder, London. 154pp.

Leske, N.G. 1778. *Additamenta ad Jacob Theodor Klein Naturalem Dispositionem Echinodermatum et Lucubratiunculam de Aculeis Echinorum Marinorum*. Ex officina gleditschiana, Lipsiae. 214pp.

Levin, L.A., Etter, R.J., Rex, M.A., Gooday, A.J., Smit, C.R., Pineda, J., Stuart, C.T., Hessler, R.R. and Pawson, D. 2001. Environmental influences on regional deep-sea species diversity. *Annual Review of Ecology and Systematics* **32**: 51-93.

Liao, Y. 1989. Two new species of the genus *Amphilimna* (Echinodermata: Ophiuroidea) from southern China. *Chinese Journal of Oceanology and Limnology* **77**(4): 339-344.

Liao, Y. and Clark, A.M. 1995. *The Echinoderms of Southern China*. Science Press, Beijing. 614pp.

Linder, H.P. and Griffiths, C.L. 1999. Introduction and overview. *Transactions of the Royal Society of South Africa* **54**(1): 1-4.

Linnaeus, C. 1758. *Systema Naturae*. Stockholm. 824pp.

Litvinova, N.M. 1971. The brittle-stars of the genus *Amphiophiura* of the Pacific and Indian Oceans collected by soviet expeditions on the *Vityaz* and *Akademik Kurchakov*. (in Russian). *Transactions of the P.P. Shirshov Institute of Oceanology.* **92**: 298-316.

Litvinova, N.M. 1998. Two species of the genus *Ophiuraster* (Ophiurinae, Ophiuroidea, Echinodermata) from French collections and some remarks on the genus. *Zoosystema* **20**(3): 439-444.

Ljungman, A. 1867a. Om några nya arter af Ophiurider. *Öfversigt af Kungliga Vetenskaps-Akademiens Förhandlingar* **1866**(6): 163-166.

Ljungman, A. 1867b. Ophiuroidea viventia huc usque cognita. *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar* **23**(9): 303-336.

Ljungman, A. 1872. Förteckning öfver uti Vestindien af Dr A. Goës samt under korvetten Josefinas expedition i Atlantiska Oceanen samlade Ophiurider. *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar* **1871**(28(5)): 615-658.

Lombard, A.T., Reyers, B., Schonegevel, L.Y., Cooper, J.A.G., Smith-Adao, A.B., Nel, D.C., Froneman, P.W., Ansorge, I.J., Bester, M.N., Tosh, C.A., Strauss, T., Akkers, T., Gon, O., Leslie, R.W. and Chown, S.L. 2007. Conserving pattern and process in the Southern Ocean: designing a marine protected area in the Prince Edwards Islands. *Antarctic Science* **19**: 39-54.

Lombard, A.T., Strauss, T., Harris, J., Sink, K., Attwood, C. and Hutchings, L. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 4: Marine Component.* South African National Biodiversity Institute. Pretoria. 101pp.

Ludwig, H. 1899. Echinodermen des sansibargebietes. In: *Wissenschaftliche Ergebnisse der Reisen in Madagascar und Ostafrica in den Jahren 1889-95. Abhandlungen der Senckenbergischen Naturforschen Gesellschaft*. Voeltzkow, A. (Ed.). **21**: 537-563.

Ludwig, H. 1901. Echinodermen: Ophiuroidea. In: *Dr H.G. Bronn's Klaasen und Ordungen des Thier-reichs, wissensehalftlich dargesteldt in Wort und Bild*. Bronn, H. G. (Ed.): 745-966.

Lutjeharms, J.R.E., Cooper, J.A.G. and Roberts, M. 2000. Upwelling at the inshore edge of the Agulhas Current. *Continental Shelf Research* **20**: 737-761.

Lutjeharms, J.R.E., Monteiro, P.M.S., Tyson, P.D. and Obura, D. 2001. The oceans around southern Africa and regional effects of global change. *South African Journal of Science* **97**: 119-130.

Lütken, C.F. 1855. Bidrag til Kundskab om Slangestjernerne. I. Forelöbig Oversigt over Grönlandshavet Ophiurer. *Videnskabelige Meddelelser fra den naturhistoriske Forening i København* **6**: 95-104.

Lütken, C.F. 1856. Bidrag til Kundskab om Slangestjernerne. In: *Oversigt over de vestindiske Ophiurer. Vedenskabelige Meddelelser fra Dansk Naturhistorisk Forening i Kjöbenhavn7: 1-19.* Oersted, H. and Lütken, C. F. (Ed.). **Part II**: 1-19.

Lütken, C.F. 1859. Additamenta ad historiam Ophiuridarum. Anden Afdelning. 5 Raekke, Naturvidenskabelig og mathematisk Afdelning. *Det kongelige danske Videnskabernes Selskaps Skrifter* **5**: 177-271.

Lütken, C.F. 1869. Additamenta ad historiam Ophiuridarum. Tredie Afdelning. Det kongelige danske Videnskabernes Selskaps Skrifter. 5 Raekke. *Naturvidenskabelig og mathematisk Afdelning* **8**: 20-109.

Lütken, C.F. 1872. Ophiuridarum novarum vel cognitarum descriptiones nonnullae. Nogle nye eller mindre bekjendte lamgestjerner beskrevnemed nogle Bemaerkninger om Selvdelingen bos Straaledyrene. *Oversigt over det Kongelige Danske videnskabernes selskabs forhandlinger* **77**: 75-158.

Lütken, C.F. and Mortensen, T. 1899. Reports on an exploration off the west coasts of Mexico, central and south America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U.S. Fish

Commission streamer *Albatross*, during 1891, Lieut. Commander Z.L. Tanner, U.S.N. Commanding. *Memoirs of the Museum of Comparative Zoology at Harvard College* **23**(2): 97-205.

Lyman, T. 1861. Descriptions of new Ophiuridae, belonging to the Smithsonian Institution and to the Museum of Comparative Zoology at Cambridge. *Proceedings of the Boston Society of Natural History* **7**: 193-203; 252-262.

Lyman, T. 1862. Descriptions of new Ophiuridae. *Proceedings of the Boston Society of Natural History* **8**: 75-86.

Lyman, T. 1865. Ophiuridae and Astrophytidae. *Illustrated Catalogue of the Museum of Comparative Zoology, Harvard University* **1**: 1-200.

Lyman, T. 1869. Preliminary report on the Ophiuridae and Astrophytidae dredged in deep-water between Cuba and the Florida Reef, by L.F. de Pourtales, Assist. U.S. Coast Survey. *Bulletin of the Museum of Comparative Zoology, Harvard College* **1**(10): 309-254.

Lyman, T. 1871. Supplement to the Ophiuridae and Astrophytidae. *Illustrated Catalogue of the Museum of Comparative Zoology, Harvard University* **6**: 1-17.

Lyman, T. 1872. Note sur les Ophiurides et Euryales qui se trouvent dans les collections du Muséum d'Histoire Naturelle de Paris. *Annales des Sciences Naturelles cinquième série Zoologie et Paléontologie* **5**(16): 1-8.

Lyman, T. 1874. Ophiuridae and Astrophytidae, new and old. *Bulletin of the Museum of Comparative Zoology, Harvard College* **3**(10): 221-272.

Lyman, T. 1875. Ophiuridae and Astrophytidae. *Illustrated Catalogue of the Museum of Comparative Zoology, Harvard University* **8**(2): 1-34.

Lyman, T. 1878. Ophiuridae and Astrophytidae of the exploring Voyage of H.M.S. "*Challenger*", under Prof. Sir Wyville Thomson, F.R.S. *Bulletin of the Museum of Comparative Zoology* **5**(7): 65-168.

Lyman, T. 1879. Ophiuridae and Astrophytidae of the exploring Voyage of H.M.S. "*Challenger*", under Prof. Sir Wyville Thomson, F.R.S. *Bulletin of the Museum of Comparative Zoology* **6**(2): 17-83.

Lyman, T. 1880. *A Preliminary List of the Known Genera and Species of Living Ophiuridae and Astrophytidae, with Their Localities, and the Depth at Which They Have Been Found and References To the Principal Synonyms and Authorities*. Cambridge. 45pp.

Lyman, T. 1882. *Challenger* Reports: Ophiuroidea. In: *Challenger Reports*. Wyville Thomson, C. (Ed.). Published by Order of her Majesty's Government, London: 386.

Lyman, T. 1883. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Caribbean Sea (1878-79), and on the east coast of the United States, during the summer of 1880, by the U.S. coast survey steamer "*Blake*", commander J.R. Bartlett, U.S.N., commanding. 20. Report on the Ophiuroidea. *Bulletin of the Museum of Comparative Zoology at Harvard College* **10**(6): 227-287.

Macnae, W. and Kalk, M. 1958. *A Natural History of Inhaca Island, Mozambique, 1st Edition.* Witwatersrand University Press. 163pp.

Macnae, W. and Kalk, M. 1962. The fauna and flora of sand flats at Inhaca Island, Mozambique. *Journal of Animal Ecology.* **31**: 93-128.

Macnae, W. and Kalk, M. 1969. *A Natural History of Inhaca Island, Mozambique*. Witwatersrand University Press, Johannesburg. 162pp.

Madsen, F.J. 1951. *Reports of the Swedish Deep-sea Expedition 1947-1948: Ophiuroidea*. Elanders Boktryckeri aktiebolag, Göteborg. 173pp.

Madsen, F.J. 1955. Echinoderms other than holothurians collected in the Sub-antarctic and Antarctic seas, mainly by the Norvegia-Expeditions 1928-1930. *Scientific results of the Norwegian Antarctic Expeditions, 1927-1928* **37**: 1-17.

Madsen, F.J. 1956. Echinoidea, Asteroidea and Ophiuroidea from depths exceeding 6000 meters. *Galathea Reports* **2**: 23-32.

Madsen, F.J. 1967. Ophiuroidea. In: *BANZ Antarctic Research Expedition 1929-1931, under the command of Sir Douglas Mawson (BANZARE Reports Series B)*. Johnston, T. H., Thomas, P. M. and Mawson, D. (Ed.). Mawson Institute For Antarctic Research, University of Adelaide, Adelaide. **9**: 121-145.

Madsen, F.J. 1970. West African Ophiuroids. *Atlantide Report* **11**: 151-243.

Madsen, F.J. 1977. The Ophioleucidae. *Galathea Reports* **14**: 109-122.

Madsen, F.J. 1983. A review of the Ophioleucinae stat. rev. (Echinodermata, Ophiuroidea) with the erection of a new genus. *Steenstrupia, Zoological Museum University of Copenhagen* **9**(2): 26-69.

Mah, C.L., McKnight, D.G., Eagle, M.K., Pawson, D.L., Ameziane, N., Vance, D.J., Baker, A.N., Clark, H.E.S. and Alcock, N. 2009. Phylum Echinodermata. In: *The New Zealand Inventory of Biodiversity. Volume 1. Kingdom Animalia: Radiata, Lophotrochozoa, Deuterostomia*. Gordon, D. P. (Ed.). Canterbury University Press, Christchurch. **1**: 371-400.

Manso, C.L.C. 2010. Deep-water Ophiuroidea (Echinodermata) from off Chile in the eastern south Pacific. *Biota Neotropica* **10**(2): 1-15.

Marktanner-Turneretscher, G. 1887. Beschreibung neuer Ophiuriden und Bemerkungen zu bekannten. *Annalen des Naturhistorischen Museums in Wien, Naaturhistorisches Museum (Austria)* **2**: 291-316.

Marsh, L.M. 1986. Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north western Australia. Part 6. Echinoderms. *Records of the Western Australian Museum Supplement* **25**: 63-74.

Marsh, L.M. and Morrison, S.M. 2004. Echinoderms of the Dampier Archipelago, Western Australia. *Records of the Western Australian Museum Supplement* **66**: 293-342.

Marsh, L.M., Vail, L., Hoggett, A.K. and Rowe, F.W.E. 1993. Echinoderms of Ashmore Reef and Cartier Island, north-western Australia. *Records of the Western Australian Museum Supplement* **44**: 53-65.

Martinez, S. 2008. Shallow-water Asteroidea and Ophiuroidea of Uruguay: composition and biogeography. *International Journal of Tropical Biology Supplement* **56**(3): 205-214.

Martynov, A. 2010. Reassessment of the classification of the Ophiuroidea (Echinodermata), based on morphological characters. I. General character evaluation and delineation of the families Ophiomyxidae and Ophiacanthidae. *Zootaxa* **2697**: 1-154.

Martynov, A. and Litvinova, N.M. 2008. Deep-water Ophiuroidea of the northern Atlantic with descriptions of three new species and taxonomic remarks on certain genera and species. *Marine Biology Research* **4**(1-2): 76-111.

Matsumoto, H. 1915. A new classification of the Ophiuroidea: with descriptions of new genera and species. *Proceedings of the Academy of Natural Sciences of Philadelphia* **67**(1): 43-92.

Matsumoto, H. 1917. A monograph of Japanese Ophiuroidea, arranged according to a new classification. *Journal of the College of Science, Imperial University, Tokyo* **38**(2): 1-408.

Mbongwa, N.A. 2013. Phylogenetic marker identification in brittle stars (Echinodermata: Ophiuroidea) from the east coast of South Africa. BSc Honours. School of Life Sciences, University of KwaZulu-Natal: 32pp.

McKnight, D.G. 1975. Some echinoderms from the northern Tasman Sea. *New Zealand Oceanographic Institute Records* **2**(5): 49-76.

McKnight, D.G. 2000. *The Marine Fauna of New Zealand: Basket-stars and Snake-stars (Echinodermata: Ophiuroidea: Euryalinida)*. National Institute of Water and Atmospheric Research, Wellington. 79pp.

McKnight, D.G. 2003. New brittle-stars (Echinodermata: Ophiuroidea) from New Zealand waters. *Zootaxa* **352**: 1-36.

McQuaid, C.D. and Branch, G.M. 1984. Influence of sea temperature, substratum and wave exposure on rocky intertidal communities: an analysis of faunal and floral biomass. *Marine Ecology Progress Series* **19**: 145-161.

McQuaid, C.D. and Branch, G.M. 1985. Trophic structure of rocky intertidal communities: response to wave action and implications of energy flow. *Marine Ecology Progress Series* **22**: 153-161.

McQuaid, C.D. and Lindsay, T.L. 2007. Wave exposure effects on population structure and recruitment in the mussel *Perna perna* suggest regulation primarily through availability of recruits and food, not space. *Marine Biology* **151**: 2123-2131.

Michelin, H.M. 1862. Echinides et Stelleredes. In: *Notes sur l'ile de la Réunion*. Maillard, L. (Ed.). Dentu Libraire Palais-Royal, Paris: 1-7.

Millard, N.A.H. 1975. Monograph on the Hydroida of southern Africa. *Annals of the South African Museum* **68**: 1-513.

Milne, R. 2012. Macroinvertebrates associated with macrophytes in Sodwana Bay, with further consideration of amphipod taxonomy. MSc. Department of Biological Sciences, University of Cape Town: 177pp.

Miloslavich, P., Díaz, J.M., Klein, E., Alvarado, J.J., Diaz, C., Gobin, J., Escobar-Briones, E., Cruz-Motta, J.J., Weil, E., Cortés, J., Bastidas, A.C., Robertson, R., Zapata, F., Martín, A., Castillo, J., Kazandijian, A. and Oritz, M. 2010. Marine biodiversity in the Caribbean: regional estimates and distribution patterns. *Plos One* **5**(8): e11916. doi:10.1371/journal.pone.0011916.

Monniot, C., Monniot, F., Griffiths, C.L. and Schleyer, M.H. 2001. South African ascidians. *Annals of the South African Museum* **108**(1): 1-141.

Monteiro, A.M.G. and Tommasi, L.R. 1983. Ophiuroidea das regiões Antartica e subantartica. 2. Variação em *Gorgonocephalus chilensis* (Philippi) (Echinodermata, Ophiuroidea, Gorgonocephalidae). *Boletim do Instituto Oceanográfico de São Paulo* **32**(1): 33-54.

Morgans, J.F.C. 1959. The benthic ecology of False Bay. ii. Soft and rocky bottoms observed by diving and sampled by dredging, and the recognition of grounds. *Transactions of the Royal Society of South Africa* **36**: 288-334.

Morgans, J.F.C. 1962. The benthic ecology of False Bay. i. Infratidal rocks observed by diving, related to that of intertidal rocks. *Transactions of the Royal Society of South Africa* **35**: 387-442.

Mortensen, T. 1903. *Echinoidea (Part 1). Danish Ingolf-Expedition*. Bianco Luno, Copenhagen. 200pp.

Mortensen, T. 1909. *Die Echinoiden der Deutschen Südpolar-Expedition 1901-1903*. Georg Reimer, Berlin. 114pp.

Mortensen, T. 1920. Notes on some Scandinavian echinoderms with descriptions of two new ophiuroids. *Universitetets Zoologiske Museum, København* **13**: 45-79.

Mortensen, T. 1924. Echinoderms of New Zealand and the Auckland-Campbell Islands. II. Ophiuroidea. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **77**: 91-177.

Mortensen, T. 1925. On some echinoderms from South Africa. *Annals and Magazine of Natural History* **9**(16): 146-154.

Mortensen, T. 1927. *Handbook of the Echinoderms of the British Isles*. Humphrey Milford, Oxford University Press. 471pp.

Mortensen, T. 1928. *A Monograph of the Echinoidea. 1. Cidaroidea.* C.A. Reitzel, Copenhagen. 551pp.

Mortensen, T. 1933a. Biological observations on ophiurids, with descriptions of two new genera and four new species. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **93**: 171-195.

Mortensen, T. 1933b. *The Danish Ingolf-Expedition. Ophiuroidea.* Bianco Luno, Copenhagen. 121pp.

Mortensen, T. 1933c. Echinoderms of South Africa (Asteroidea and Ophiuroidea). *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **93**: 215-400.

Mortensen, T. 1933d. The echinoderms of St Helena (other than Crinoids). *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **93**: 401-472.

Mortensen, T. 1933e. Studies of Indo-Pacific Euryalids. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **96**: 1-75.

Mortensen, T. 1934. Echinoderms from Hong Kong. *Hong Kong Naturalist* **(Suppl. 3)**: 3-14.

Mortensen, T. 1935. *A Monograph of the Echinoidea. 2. Bothriocidaroida, Melonechinoida, Lepidocentroida and Stirodonta.* C.A. Reitzel, Copenhagen. 647pp.

Mortensen, T. 1936. *Discovery Reports: Echinoidea and Ophiuroidea*. Cambridge University Press, Cambridge. 167pp.

Mortensen, T. 1940. Echinoderms from the Iranian Gulf. Asteroidea, Ophiuroidea and Echinoidea. *Danish Scientific Expeditions in Iran* **2**: 55-110.

Mortensen, T. 1943a. *A Monograph of the Echinoidea. 3(2). Camarodonta. 1.* C.A. Reitzel, Copenhagen. 553pp.

Mortensen, T. 1943b. *A Monograph of the Echinoidea. 3(3). Camarodonta. 2.* C.A. Reitzel, Copenhagen. 446pp.

Mortensen, T. 1948a. *A Monograph of the Echinoidea. 4(2). Clypeastroida*. C.A. Reitzel, Copenhagen. 471pp.

Mortensen, T. 1948b. Report on the Echinoidea of the Murray Expedition. II [Irregular Echinoidea]. *Scientific Reports on the John Murray Expedition* **9**: 1-15.

Müller, J.H. and Troschel, F.H. 1840a. Über die Gattungen der Asterien. *Archiv für Naturgeschichte, Berlin* **6**: 318-326.

Müller, J.H. and Troschel, F.H. 1840b. Über die Gattungen der Ophiuren. *Archiv für Naturgeschichte, Berlin* **6**: 326-330.

Müller, J.H. and Troschel, F.H. 1842. *System der Asteriden*. F. Vieweg & Sohn, Braunschweig. 134pp.

Müller, O.F. 1789. *Zoologia Danica seu Animalium Daniae et Norwegiae rariorum ac minus notorum.* Avlae regiae typographi et filii, Copenhagen. 658pp.

Murakami, S. 1942. Ophiurans of Izu, Japan. *Journal of the Department of Agriculture, Kyushu Imperial University* **7**(1): 1-36.

Murakami, S. 1943a. Report on the ophiurans of Palao Caroline Islands. *Journal of the Department of Agriculture, Kyusyu Imperial University* **7**(4): 159-203.

Murakami, S. 1943b. Report on the ophiurans of Yaeyama, Ryukyu. *Journal of the Department of Agriculture, Kyusyu Imperial University* **7**(5): 205-222.

Murray, J. 1896. On the deep and shallow-water marine fauna of the Kerguelen region of the great Southern Ocean. *Transactions of the Royal Society of Edinburgh* **38**(2): 343-500.

O'Hara, T. 2008. *Bioregionalisation of the waters around Lord Howe and Norfolk Islands using brittle stars (Echinodermata: Ophiuroidea)*. Victoria Museum, Department of Environment, Water, Heritage and the Arts, Australia, Victoria. 55pp.

O'Hara, T., Byrne, M. and Cisternas, P.A. 2004. The *Ophiocoma erinaceus* complex: another case of cryptic speciation in echinoderms. 11th International Echinoderm Conference, 6-10 October, Munich, Germany, A.A. Balkema, Netherlands, 537-542.

O'Hara, T.D. and Stöhr, S. 2006. Deep water Ophiuroidea (Echinodermata) of New Caledonia: Ophiacanthidae and Hemieuryalidae. *Mémoire du Muséum national d'Histoire Naturelle* **193**: 33-141.

O'Loughlin, M. and Waters, J.M. 2004. A molecular and morphological revision of genera of Asterinidae (Echinodermata: Asteroidea). *Memoirs of Museum Victoria* **61**(1): 1-40.

Oersted, H. and Lütken, C. 1856. Bidrag til Kundskab om Slangestjernerne. *Oversigt over de vestindiske Ophiurer. Vedenskabelige Meddelelser fra Dansk Naturhistorisk Forening i København* **7**(Part II): 1-19.

Okanishi, M. 2012. Systematic study of the Order Euryalida (Echinodermata, Ophiuroidea) from the Western Pacific. PhD. Seto Marine Biological Laboratory, Kyoto University: 463pp.

Okanishi, M. and Fujita, T. 2009. A new species of *Asteroschema* (Echinodermata: Ophiuroidea: Asteroschematidae) from southwestern Japan. *Species Diversity* **14**: 115-129.

Okanishi, M. and Fujita, T. 2011. A taxonomic review of the Genus *Astrocharis* Koehler (Echinodermata: Ophiuroidea: Asteroschematidae), with a description of a new species. *Zoological Science* **28**(2): 148-157.

Okanishi, M. and Fujita, T. 2013. Molecular phylogeny based on increased number of species and genes revealed more robust family-level systematics of the order Euryalida (Echinodermata: Ophiuroidea). *Molecular Phylogenetics and Evolution* **69**: 566-580.

Okanishi, M. and Fujita, T. 2014. A taxonomic review of the genus *Asterostegus* (Echinodermata: Ophiuroidea), with the description of a new species. *European Journal of Taxonomy* **76**: 1-18.

Okanishi, M., O'Hara, T. and Fujita, T. 2011a. Molecular phylogeny of the order Euryalida (Echinodermata: Ophiuroidea) based on mitochondrial and nuclear ribosomal genes. *Molecular Phylogenetics and Evolution* **61**: 392-399.

Okanishi, M., O'Hara, T. and Fujita, T. 2011b. A new genus *Squamophis* of Asteroschematidae (Echinodermata: Ophiuroidea: Euryalida) from Australia. *ZooKeys* **129**: Doi: 10.3897/zookeys.129.1202.

Okanishi, M., Olbers, J.M. and Fujita, T. 2013. A taxonomic review of the genus *Asteromorpha* Lütken (Echinodermata: Ophiuroidea: Euryalidae). *The Raffles Bulletin of Zoology* **61**(2): 461-480.

Okanishi, M., Yamaguchi, K., Horii, Y. and Fujita, T. 2011c. Ophiuroids of the Order Euryalida (Echinodermata) from Hachijojima Island and Ogasawara Islands, Japan. *National Museum of Nature and Science* **47**: 367-385.

Olbers, J.M., Rowe, F.W.E., Griffiths, C.L. and Samyn, Y. 2014. The rediscovery of a collection of Echinoderms, including two holotypes, in the Durban Natural Science Museum, South Africa. *Durban Natural Science Museum Novitates* **36**: 11-29.

Olbers, J.M. and Samyn, Y. 2012. The *Ophiocoma* species (Ophiurida: Ophiuroidea) of South Africa. *Western Indian Ocean Journal of Marine Science* **10**(2): 137-154.

Olbers, J.M., Samyn, Y. and Griffiths, C.L. 2015. New or notable records of brittle stars (Echinodermata: Ophiuroidea) from South Africa. *African Natural History* **11**: 83-116. Doi: 10.17159/2305-7963/2015/v11n1a3.

Ortmann, A.E. 1896. *Grunzuge der Marinen Tiergeographie*. Gustav Fischer, Jena. 112pp.

Parameswaran, U.V., Abdul Jaleel, K.U. and Sanjeevan, V.N. 2013. *Ophiodaphne scripta* (Ophiuroidea: Amphiuridae), a brittle star exhibiting sexual dimorphism and epibiosis: first record from India, with notes on adaptations, systematics and distribution. *Marine Biodiversity* **43**: 333-339.

Parameswaran, U.V. and Jaleel, K.U. 2012. *Asteroschema sampadae* (Ophiuroidea: Asteroschematidae), a new deep-sea brittle star from the continental slope off the southern tip of India. *Zootaxa* **3269**: 47-56.

Paterson, G.L.J. 1985. The deep sea Ophiuroidea of the north Atlantic Ocean. *Bulletin of the British Museum (Natural History) Zoology* **49**(1): 1-162.

Paterson, G.L.J., Tyler, P.A. and Gage, J.D. 1982. The taxonomy and zoogeography of the genus *Ophiocten* (Echinodermata: Ophiuroidea) in the north Atlantic Ocean. *Bulletin of the British Museum (Natural History) Zoology* **43**(4): 109-128.

Pawson, D.L. 2007. Phylum Echinodermata. *Zootaxa* **1668**: 749-764.

Pennant, T. 1777. *British Zoology: Crustacea, Mollusca, Testacea*. Benj White, London. 154pp.

Penrith, M.L. and Kensley, B.F. 1970. The constitution of the intertidal fauna of rocky shores of South West Africa. 1. Luderitzbucht. *Cimbebasia* **A1**: 192-239.

Perrier, J.O.E. 1869. Recherches sur les Pédicellaires et les Ambulacres de Astéries et des Oursins. Faculté Sciences de Paris: 188pp.

Perrier, J.O.E. 1875. Revision de la collection de stellerides du museum d'histoire Naturelle de Paris. *Archives de Zoologie Experimentale* **5**: 1-384.

Perrier, J.O.E. 1881. Description sommaire des espéces nouvelles d'Astéries. *Bulletin of the Museum of Comparative Zoology at Harvard College* **9**(1): 1-31.

Perrier, J.O.E. 1884. Mémoire sur les étoiles de mer recueillies dans la mer des Antilles et le Golf du Mexique. *Nouvelles Archives du Muséum d'Histoire Naturelle* **6**(2): 127-276.

Peters, W. 1851. Übersicht der an der Küste von Mossambique eingesammelten Ophiuren, unter denen sich zwei neue Gattungen befinden. 1851, 463-466. *Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königlich Preussischen Akademie der Wissenschaften zu Berlin* **1851**: 463-466.

Philippi, R.A. 1858. Beschreibung einiger neuen Seesterne aus dem Meere von Chiloë. *Archiv für Naturgeschchte* **1**(1): 264-268.

Picker, M.D. and Griffiths, C.L. 2011. *Alien and Invasive Animals: a South African Perspective*. Struik, Cape Town. 240pp.

Pomory, C.M. 2003. A guide to the shallow-water Echinodermata of the Texas coast. *Contributions to Marine Science* **36**: 1-188.

Pomory, C.M. 2007. Key to the common shallow-water brittle stars (Echinodermata: Ophiuroidea) of the Gulf of Mexico and Caribbean Sea. *Caribbean Journal of Science Special Publication* **10**: 1-42.

Porter, S.N. 2009. Biogeography and potential factors regulating shallow subtidal reef communities in the Western Indian Ocean. PhD. Faculty of Science, University of Cape Town: 279pp.

Price, A.R.G. 1981. Studies of the echinoderm fauna of the western Arabian Gulf. *Journal of Natural History* **15**: 1-15.

Price, A.R.G. 1982. Echinoderms of Saudi Arabia. Comparison between echinoderm faunas of Arabian Gulf, south east Arabia, Red Sea and Gulfs of Aqaba and Suez. *Fauna of Saudi Arabia* **4**: 3-21.

Price, A.R.G. and Rowe, F.W.E. 1996. Indian Ocean echinoderms collected during the *Sinbad Voyage* (1980-1981): 3. Ophiuroidea and Echinoidea. *Bulletin of the Natural History Museum of London (Zoology)* **62**(2): 71-82.

Primo, C. and Vazquez, E. 2004. Zoogeography of the southern African ascidian fauna. *Journal of Biogeography* **31**: 1987-2009.

Procheş, S. and Marshall, D.J. 2002. Diversity and biogeography of southern African intertidal Acari. *Journal of Biogeography* **29**: 1201-1215.

Putchakarn, S. and Sonchaeng, P. 2004. Echinoderm fauna of Thailand. *Science Asia* **30**: 417-428.

Retzius, A.J. 1783. Anmärkningar vid Asteriæ genus. *Kungliga Svenska Vetenskapsakademiens handlingar* **4**: 230-248.

Rex, M.A., McClain, C.R., Johnson, N.A., Etter, R.J., Allen, J.A., Bouchet, P. and Warén, A. 2005. A source-sink hypothesis for abyssal biodiversity. *The American Naturalist* **165**(2): 163-178.

Reza Fatemi, S.M., Jamili, S., Valinassab, T. and Kuranlu, N. 2010. Diversity of Ophiuroidea from Lengeh Portand Qeshm Island in the Persian Gulf. *Journal of Fisheries and Aquatic Science* **5**(1): 42-48.

Richmond, M.D. 2002. *A Field Guide to the Seashores of Eastern Africa and the Western Indian Ocean*. Sida/SAREC-UDSM. 461pp.

Rodrigues, C.F., Paterson, G.L.J., Cabrinovic, A. and Cunha, M.R. 2011. Deep-sea ophiuroids (Echinodermata: Ophiuroidea: Ophiurida) from the Gulf of Cadiz (NE Atlantic). *Zootaxa* **2754**: 1-26.

Roel, B.A. 1987. Demersal communities off the west coast of South Africa. *South African Journal of Marine Science* **5**: 575-584.

Rowe, F.W.E. 1989. Nine new deep-water species of Echinodermata from Norfolk Island and Wanganella Bank, northeastern Tasman Sea, with a checklist of the echinoderm fauna. *Proceedings of the Linnean Society of New South Wales* **111**(4): 257-291.

Rowe, F.W.E. and Gates, J. 1995. *Echinodermata*. CSIRO, Melbourne. 510pp.

Rowe, F.W.E. and Pawson, D.L. 1977. A catalogue of echinoderm type specimens in the Australian Museum, Sydney. *Records of the Australian Museum* **30**(14): 337-364.

Rowe, F.W.E. and Richmond, M.D. 2004. A preliminary account of the shallow water echinoderms of Rodrigues, Mauritius, Western Indian Ocean. *Journal of Natural History* **38**: 3273-3314.

Samaai, T. 2006. Biodiversity 'hotspots', patterns of richness and endemism, and distribution of marine sponges in South Africa based on actual and interpolated data: a comparative approach. *Zootaxa* **1358**: 1-37.

Samaai, T., Gibbons, M.J., Kerwath, S.E., Yemane, D. and Sink, K. 2010. Sponge richness along a bathymetric gradient within the iSimangaliso Wetland Park, South Africa. *Marine Biodiversity* **40**: 205-217. Doi: 10.1007/s12526-010-0046-z.

Samyn, Y. 2003. Shallow water regular echinoids (Echinodermata: Echinoidea) from Kenya. *African Zoology* **38**(2): 193-212.

Samyn, Y. and Thandar, A.S. 2003. Towards an understanding of the shallow-water echinoderm biodiversity of KwaZulu-Natal, Republic of South Africa. In: *Echinoderm Research 2001*. Féral, J. and David, B. (Ed.). Swets & Zeitlinger, Lisse, The Netherlands: 41-47.

Sars, M. 1861. *Oversigt of Norges Echinodermer*. Videnskabs-Selskabet i Christiania, Christiania 160pp.

Sastry, D.R.K. 1991. Echinodermata: Asteroidea, Ophiuroidea and Echinoidea. In: *Fauna of Lakshadweep. State Fauna Series.* Ghosh, A. K. (Ed.). Zoological Survey of India, Calcutta. **2**: 363-439.

Scott, R. 2009. Biogeographical patterns of southern African marine invertebrates. MSc. Department of Zoology, University of Cape Town: 97pp.

Seno, J. and Irimura, S. 1968. Ophiuroidea collected from around the Ross Sea in 1964 with description of a new species. *Journal of the Tokyo University of Fisheries* **9**(2): 147-154.

Shannon, L.V. 1985. The Benguela ecosystem: 1. Evolution of the Benguela, physical features and processes. *Oceanography and Marine Biology: an Annual Review* **23**: 105-182.

Silvertown, J., Harvey, M., Greenwood, R., Dodd, M., Rosewell, J., Rebelo, T., Ansine, J. and McConway, K. 2015. Crowdsourcing the identification of organisms: A case-study of iSpot. *ZooKeys* **480**: 125-146. Doi: 10.3897/zookeys.480.8803.

Sink, K.J. 2001. A hierarchical analysis of abiotic determinants and harvesting impacts in the rocky intertidal communities of KwaZulu-Natal. PhD. Faculty of Science, University of Cape Town: 277pp.

Sink, K.J., Boshoff, W., Samaai, T., Timm, P.G. and Kerwath, S.E. 2006. Observations of the habitats and biodiversity of the submarine canyons at Sodwana Bay. *South African Journal of Science* **102**: 466-474.

Sink, K.J., Branch, G.M. and Harris, J.M. 2005. Biogeographic patterns in rocky intertidal communities in KwaZulu-Natal, South Africa. *African Journal of Marine Science* **27**(1): 81-96.

Sink, K.J., Holness, S., Harris, L., Majiedt, P.A., Atkinson, L., Robinson, T., Kirkman, S., Hutchings, L., Leslie, R., Lamberth, S., Kerwath, S., von der Heyden, S., Lombard, A.T., Attwood, C., Branch, G., Fairweather, T., Taljaard, S., Weerts, S., Cowley, P., Awad, A., Halpern, B., Grantham, H. and Wolf, T. 2012. *National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine and Coastal Component*. South African National Biodiversity Institute. Pretoria. 332pp.

Sladen, W.P. 1878. On *Astrophiura permira*, an echinoderm intermediate between Ophiuroidea and Asteroidea. *Proceedings of The Royal Society of London* **27**: 456-457.

Sladen, W.P. 1879. On the structure of *Astrophiura*, a new and aberrant genus of Echinodermata. *Annals and Magazine of Natural History* **4**: 401-415.

Sladen, W.P. 1883. The Asteroidea of H.M.S. '*Challenger*' Expedition, Part I. *Journal of the Linnean Society of London, Zoology* **16**: 189-245.

Sloan, N.A., Clark, A.M. and Taylor, J.D. 1979. The echinoderms of Aldabra and their habitats. *Bulletin of the British Museum (Natural History) Zoology* **37**(2): 81-128.

Smirnov, I.S., Piepenburg, D., Ahearn, C.G. and Juterzenka, K.V. 2014. Deep-sea fauna of European seas: Annotated species check-list of benthic invertebrates living deeper than 2000m in the seas bordering Europe. Ophiuroidea. *Invertebrate Zoology* **11**(1): 192-209.

Smith, A.B., Paterson, G.L.J. and Lafay, B. 1995. Ophiuroid phylogeny and higher taxonomy: morphological, molecular and paleontological perspectives. *Zoological Journal of the Linnean Society* **114**: 213-243.

Smith, E.A. 1876. Descriptions of two new species of *Ophiocoma*. *Annals and Magazine of Natural History* **18**(1): 39-40.

Soliman, F.E. 1989. Studies on the Egyptian Echinodermata. *Ophiocoma latilanaxa* (Ophiuroidea: Ophiocomidae). A new record from the Red Sea. *Bulletin of the Faculty of Science Assiut University* **18**: 97-105.

Soliman, F.E. 1991. Studies on the Egyptian Echinodermata. *Ophiocoma aegyptiaca* sp. nov. from the Red Sea. *Galaxea* **10**: 79-88.

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdana, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A. and Robertson, J. 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *Bioscience* **57**(7): 573-583.

Spencer, W.K. and Wright, C.W. 1966. Part U: Echinodermata. In: *Morphology and Function*. Moore, R. C. (Ed.). Geological Society of America and University of Kansas Press, Lawrence. **Part U**: 695.

Stefanini, G. 1912. Osservazioni sulla distribuzione geografica, sulla origini e sulla filogenesi degli Scutellidae. *Bolletino della Società Geologica Italiana* **30**(1911): 739-754.

Stephenson, T.A. 1939. The constitution of the intertidal fauna and flora of South Africa, Part I. *Journal of the Linnean Society of London, Zoology* **40**: 487-536.

Stephenson, T.A. 1944. The constitution of the intertidal fauna and flora of South Africa. Part II. *Annals of the Natal Museum* **5**(3): 261-357.

Stephenson, T.A. and Stephenson, A. 1972. *Life Between Tidemarks on Rocky Shores*. WH Freeman and Company, San Francisco. 425pp.

Stephenson, T.A., Stephenson, A. and Bright, K.M.F. 1938. The South African intertidal zone and its relation to ocean currents. IV. The Port Elizabeth district. *Annals of the Natal Museum* **9**(1): 1-20.

Stephenson, T.A., Stephenson, A. and du Toit, C.A. 1937. The South African intertidal zone and its relation to ocean currents. I. *Transactions of the Royal Society of South Africa* **24**: 341-382.

Stiasny, V.G. and Groenewegen, A.W. 1929. Verzeichnis der Ophiuriden-Sammlung des Naturhistorischen Reichmuseums in Leiden. *Zoologische Mededelingen* **12**: 176-194.

Stöhr, S. 2001. Species of echinoderms described by A.W. Ljungman. Proceedings of the 10th International Echinoderm Conference, 31 January-4 February 2000, Dunedin, New Zealand, Balkema (Swets & Zeitlinger), 67-72.

Stöhr, S. 2005. Who's who among baby brittle stars (Echinodermata: Ophiuroidea): post metamorphic development of some North Atlantic forms. *Zoological Journal of the Linnean Society* **143**: 543-576.

Stöhr, S. 2007a. *Amphilimna valida* (Clark, 1939). In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/Ophiuroidea/aphia.php?p=taxdetails&id=242645. Accessed: 25 June 2016.

Stöhr, S. 2007b. *Amphiophiura trifolium* Hertz, 1927. In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=214621. Accessed: 25 June 2016.

Stöhr, S. 2007c. *Asteronyx loveni* Müller & Troschel, 1842. In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2016). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=124951. Accessed: 25 June 2016.

Stöhr, S. 2007d. *Ophiomyxa australis* Lütken, 1869. In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=212437. Accessed: 25 June 2016.

Stöhr, S. 2007e. *Ophiopeza spinosa* (Ljungman, 1867). In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=212321. Accessed: 25 June 2016.

Stöhr, S. 2007f. *Ophioplocus imbricatus* (Müller & Troschel, 1842). In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=243985. Accessed: 25 June 2016.

Stöhr, S. 2007g. *Ophiothela venusta* (de Loriol, 1900). In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=213400. Accessed: 25 June 2016.

Stöhr, S. 2007h. *Ophiothrix (Acanthophiothrix) proteus* Koehler, 1905. In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=244143. Accessed: 25 June 2016.

Stöhr, S. 2007i. *Ophiothrix (Acanthophiothrix) purpurea* von Martens, 1867. In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=244144. Accessed: 25 June 2016.

Stöhr, S. 2011a. New records and new species of Ophiuroidea (Echinodermata) from Lifou, Loyalty Islands, New Caledonia. *Zootaxa* **3089**: 1-50.

Stöhr, S. 2011b. *Ophiothrix (Ophiothrix) foveolata* Marktanner-Turneretscher, 1887. In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2015). World Ophiuroidea database http://www.marinespecies.org/ophiuroidea/aphia.php?p=taxdetails&id=244174. Accessed: 25 June 2016.

Stöhr, S. 2011c. *Ophiothrix fragilis* var. *triglochis* Müller & Troschel, 1842. In: Stöhr, S.; O'Hara, T. & Thuy, B. (Eds) (2015) World Ophiuroidea database. http://www.marinespecies.org/Ophiuroidea/aphia.php?p=taxdetails&id=576292. Accessed: 2 July 2016.

Stöhr, S., Boissin, E. and Chenuil, A. 2009. Potential cryptic speciation in Mediterranean populations of *Ophioderma* (Echinodermata: Ophiuroidea). *Zootaxa* **2071**: 1-20.

Stöhr, S., Boissin, E. and Hoareau, T. 2013. Taxonomic revision and phylogeny of the *Ophiocoma brevipes* group (Echinodermata, Ophiuroidea), with description of a new subgenus (*Breviturma*) and a new species. *European Journal of Taxonomy* **68**: 1-26.

Stöhr, S., Conand, C. and Boissin, E. 2008. Brittle stars (Echinodermata: Ophiuroidea) from La Réunion and the systematic position of *Ophiocanops* Koehler, 1922. *Zoological Journal of the Linnean Society* **153**: 545-560.

Stöhr, S. and Hansson, H. 2010. *Ophiothrix fragilis* (Abildgaard, in O.F. Müller, 1789). In: Stöhr, S., O'Hara, T.D. & Thuy, B. (Eds) (2016). World Ophiuroidea database http://www.marinespecies.org/Ophiuroidea/aphia.php?p=taxdetails&id=125131. Accessed: 25 June 2016.

Stöhr, S., O'Hara, T.D. and Thuy, B. 2012. Global diversity of brittle stars. *Plos One* **7**(3): e31940. doi:10.1371/journal.pone.0031940.

Stöhr, S., O'Hara, T.D. and Thuy, B. 2014. World Ophiuroidea database http://www.marinespecies.org/ophiuroidea. Accessed: 14 October 2014.

Stöhr, S., O'Hara, T.D. and Thuy, B. 2016. World Ophiuroidea database http://www.marinespecies.org/ophiuroidea. Accessed: 25 June 2016.

Stuart, C.T., Rex, M.A. and Etter, R.J. 2003. Ecosystems of the deep ocean: Large-scale spatial and temporal patterns of deep-sea benthic species diversity. In: *Ecosystems of the World*. Tyler, P. A. (Ed.). Elsevier, Amsterdam. **28**: 297-313.

Studer, T. 1876. Dr. Th. Studer über Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln gesammelt auf der Reise S.M.S. Corvette *Gazelle* um die Erde. *Monatsbericht der Königlich-Preussischen Akademie der Wissenschaften zu Berlin* **1876**: 425-465.

Studer, T. 1882. Übersicht über die Ophiuriden, welche während der Reise S.M.S. "*Gazelle*" um die Erde 1874-76 gesammelt wurden. *Abhandlungen der Königlichen Akademie der Wissenschaften in Berlin* **34**(1-37)

Studer, T. 1885. Verzeichniss der während der Reise S.M.S. '*Gazelle*' um die erde 1874-76 gesammelten Asteriden und Euryaliden. *Monatsbericht der Königlich-Preussischen Akademie der Wissenschaften zu Berlin* **1884**: 1-64.

Sumida, P.Y.G., Tyler, P.A., Gage, J.D. and Norrevang, A. 1998. Postlarval development in shallow and deep-sea ophiuroids (Echinodermata: Ophiuroidea) of the north east Atlantic Ocean. *Zoological Journal of the Linnean Society* **124**: 267-300.

Thandar, A.S. 1984. The Holothurian fauna of Southern Africa. PhD. Department of Zoology, University of Durban-Westville: 566pp.

Thandar, A.S. 1989. Zoogeography of the southern African echinoderm fauna. *South African Journal of Zoology* **24**(4): 311-318.

Thandar, A.S. 2015. Biodiversity and distribution of the southern African sea cucumbers (Echinodermata: Holothuroidea). *Zootaxa* **4058**(3): 341-361.

Thomas, L.P. 1962. The shallow water amphiurid brittle stars (Echinodermata, Ophiuroidea) of Florida. *Bulletin of Marine Science of the Gulf and Caribbean* **12**(4): 623-694.

Thomas, L.P. 1967. The systematic position of *Amphilimna* (Echinodermata: Ophiuroidea). *Proceedings of the Biological Society of Washington* **80**: 123-130.

Thomas, L.P. 1975. The ophiacanthid genus *Amphilimna* (Ophiuroidea: Echinodermata). *Proceedings of the Biological Society of Washington* **88**: 127-139.

Tittensor, D.P., Mora, C., Jetz, W., Lotze, H.K., Ricard, D., vanden Berghe, E. and Worm, B. 2010. Global patterns and predictors of marine biodiversity across taxa. *Nature* **466**: 1098-1103. Doi: 10.1038/nature09329.

Tortonese, E. 1936. Echinodermi del Mar Rosso. *Annali Museo Civico Storia Naturale* **59**: 202-245.

Tortonese, E. 1977. Report on echinoderms from the Gulf of Aqaba (Red Sea). *Monitore Zoologico Italiano (Italian Journal of Zoology)* **9**(1): 273-290.

Tortonese, E. 1980. Reseaches on the coast of Somalia. Littoral Echinodermata. *Monitore Zoologico Italiano (Italian Journal of Zoology)* **13**(5): 99-139.

Troschel, F.H. 1872. Die Familie der Echinocidariden. *Archiv für Naturgeschichte* **38**: 293-356.

Troschel, F.H. 1879. Eine neue Art der Ophiuridengattung *Ophiarachna*. *Sitzungsberichte der niederrheinischen Gesellschaft fuer Natuurund Heilkunde in Bonn* **1879**: 135-138.

Tsurnamal, M. and Marder, J. 1966. Contributions to the knowledge of the Red Sea, No. 33. Observations on the basket star *Astroboa* (Lyman) on coral reefs at Eilat (Gulf of Aqaba). *Israel Journal of Zoology* **15**: 9-17.

Turpie, J.K., Beckley, L.E. and Katua, S.M. 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. *Biological Conservation* **92**: 59-72.

Vadon, C. and Guille, A. 1984. Les Ophiuridae (Ophiuroidea, Echinodermata) de la campagne MD 32 du *Marion-Dufresne* autour de l'ile de La Reunion. *Bulletin Muséum National d'Histoire Naturelle* **4**(6): 583-615.

Vail, L. and Rowe, F.W.E. 1989. Status of the genera *Ophiopeza* and *Ophiopsammus* (Echinodermata: Ophiuroidea) in Australian waters, with the description of a new species. *Proceedings of the Linnean Society of New South Wales* **110**(3): 267-288.

Van den Berg, R. 2008. GEF Country Portfolio Evaluation: South Africa (1994-2007). Global Environment Facility Evaluation Office. Washington. 160pp.

Van den Hoek, C. 1975. Phytogeographic provinces along the coast of the northern Atlantic Ocean. *Phycologia* **14**: 317-330.

Van den Hoek, C. and Donze, M. 1967. Algal phytogeography of the European Atlantic coasts. *Blumea* **15**: 63-89.

Vanreusel, A., Fonseca, G., Danovaro, R., da Silva, M.C., Esteves, A.M., Ferrero, T., Gad, G., Galtsova, V., Gambi, C., da Fonséca Genevois, V., Ingels, J., Ingole, B., Lampadariou, N., Merckx, B., Miljutin, D., Miljutina, M., Muthumbi, A., Netto, S., Portnova, D., Radziejewska, T., Raes, M., Tchesunov, A., Vanaverbeke, J., Van Gaever, S., Venekey, V., Bezerra, T.N., Flint, H., Copley, J., Pape, E., Zeppilli, D., Martinez, P.A. and Galeron, J. 2010. The contribution of deep-sea macrohabitat heterogeneity to global nematode diversity. *Marine Ecology* **31**: 6-20.

Verrill, A.E. 1867. Notes on the Radiata in the Museum of Yale College, with descriptions of new genera and species. No. 2. Notes on the Echinoderms of Panama and west coast of America, with descriptions of new genera and species. *Transactions of the Connecticut Academy of Arts and Sciences* **1**(2): 252-322.

Verrill, A.E. 1869. On new and imperfectly known echinoderms and corals. *Proceedings of the Boston Society of Natural History* **12**: 381-391.

Verrill, A.E. 1870. Notes on the Radiata in the Museum of Yale College: No. 3. On the geographical distribution of echinoderms of the Pacific coast of America. *Transactions of the Connecticut Academy of Arts and Sciences* **1**(2): 323-351.

Verrill, A.E. 1894. Descriptions of new species of starfishes and ophiurans, with a revision of certain species formerly described, mostly from the collections made by the United States Commission of Fish and Fisheries. *Proceedings of the United States National Museum* **17**: 245-297.

Verrill, A.E. 1899a. North American Ophiuroidea. I. Revision of certain families and genera of west Indian Ophiurans. II. A faunal catalogue of the known species of West Indian Ophiurans. *Transactions of the Connecticut Academy of Arts and Sciences* **10**(7): 301-386.

Verrill, A.E. 1899b. Report on the Ophiuroidea collected by the Bahama Expedition in 1893. *Bulletin from the Laboratories of Natural History of the State University of Iowa* **5**(1): 1-86.

Vine, P.J. 1986. *Red Sea Invertebrates*. Immel Publishing, Tokyo. 224pp.

Von Martens, E. 1867a. Über ostasiatische Echinodermen. *Archiv für Naturgeschichte* **33**: 106-120.

Von Martens, E. 1867b. Über vier neue Schlangensterne (Ophiuren) des Kongel Zoologischen Museums. *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften* **1867**: 345-348.

Von Martens, E. 1869. Seesterne und Seeigel. *Baron Carl Claus von der Decken's Reisen in Ost-Afrika in den Jahren 1859–1865* **3**: 124-134.

Von Martens, E. 1870. Die Ophiuriden des indischen Oceans. *Archiv für Naturgeschichte* **36**: 244-262.

Von Martens, E. 1879. Vorzeigung eines eigenthümlichen sechsarmigen Schlangensterns, *Ophiothela dividua*, sp. n. *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin* **1879**: 127-130.

Williams, G.C. 1992. Biogeography of the octocorallian coelenterate fauna of southern Africa. *Biological Journal of the Linnean Society* **46**: 351-401.

Wilson, M.V. and Shmida, A. 1984. Measuring beta diversity with presence-absence data. *Journal of Ecology* **72**: 1055-1064.

Woodward, S.P. 1856. *A Manual of the Mollusca or Rudimentary Treatise of Recent and Fossil Shells*. John Weale, London. 486pp.

Wyville Thomson, C. 1873. *The Depths of the Sea*. Macmillan and Company, London. 626pp.

Wyville Thomson, C. 1878. *The voyage of the "Challenger". The Atlantic. a preliminary account of the general results of the exploring voyage of H.M.S. "Challenger" during the year 1873 and the early part of the year 1876*. Macmillan and Company, London. 424pp.

Yemane, D., Field, J.G. and Leslie, R.W. 2009. Spatio-temporal patterns in the diversity of demersal fish communities of the south coast of South Africa. *Marine Biology* **157**: 269-281.

Ziesenhenne, F.C. 1955. A review of the genus *Ophioderma*. In: *Essays in the Natural Sciences in honour of Captain Allan Hancock, on the occasion of his birthday, July 26, 1955* (Ed.). University of Southern California Press, Los Angeles: 185-201.

Zirpolo, G. 1932. Sul *Gorgonocephalus chilensis* Lyman. *Annuario del Museo Zoologico della Regia Università do Napoli* **6**(7): 1-16.

Appendix A. Glossary of terms used during a study on the taxonomy, biodiversity and biogeography of the Ophiuroidea of South Africa.

Term	Definition / explanation
Aboral	Top or upper side of an organism. Also see dorsal.
Abut	Touching, or being next to.
Adjacent	Next to, nearest in space or position, immediately adjoining without a space.
Adoral	Situated near mouth.
Adoral shields	Pair of plates in each ventral interradius adjacent to an unpaired oral shield (Figure 1.4).
Adradial	Situated near or beside arms.
Ambulacra / ambulacral grooves	Structure/s in each radius, through which tube feet protrude.
Annulated	Furnished with or composed of rings.
Apical papillae	Papillae on apex of jaws.
Apical	Apex, tip or top of a conical or spherical structure.
Appressed	Pressed up against or close to another structure.
Approximating	Close to or similar to something.
Arm comb	Series of papillae or small spines arising from a plate distal to each radial shield opposite base of arm (Figure 1.2).
Arm plates	Plates on arms for rigidity and protection, may be distinct or not, found dorsally, ventrally and laterally (Figures 1.2 & 1.4).
Arm spines	Fleshy or spiny projections, out-growths or bumps usually hosted by lateral arm plates; also see spines (Figures 1.4).
Attenuate	Becomes thin or fine; to lessen.
Autotomise	Separation of an appendage or body part.
Basal	Part nearest to disc; see also proximal (Figure A1).
Belts of hooks	Tentacle scales or fine arm spines arranged in belts encircling arm; also see girdle belts.
Bifurcate	Divided into two (Figure A3).
Branched	Arms forming tree-like formation by splitting.
Carinate	With a keel or keel-like ridge.
Central plate	Plate / scales in centre of disc, may be a variety of shapes (Figure 1.3).
Clavate	Club-shaped; gradually becoming thicker towards end; having an enlarged terminal end (Figure A3).
Concentric	Formation of circles or arcs which share a common centre.
Constricted	To make narrower, may be in a non-uniform manner.
Contiguous	Touching or very close, unable to see separation.
Dental papillae	Papillae positioned on dental plate on jaw, dental plates can only be seen during dissections (Figure 1.4).
Diastema	Space or gap between two adjacent papillae or teeth.
Digitate	Shape of a spread hand, many lobes (Figure A3).
Disc margin	Outer edge or periphery of disc.
Distal notch	Inner area within oral slit where two jaws join.
Distal	Part of a structure farthest from centre of body, opposite to proximal (Figure A1).
Dorsal	Top or upper side of an organism.
Dorso-ventrally	Direction in which arms bend i.e. towards ventral side.
Excavate	Form a hollow.
Fenestrated	Small opening.
Fissiparous	Self-dividing across disc, followed by regeneration.
Flatten	Compressed or to decrease in height.
Flange	Projection, rim or collar on a structure, serving for strength or attachment.
Fork	Position where arm splits.
Genital papillae	Papillae located on or adjacent to genital slit (Figure 1.4).

Genital plate	Plate adjacent to genital slit.
Genital slits	Genital openings on ventral side of disc, often lying where arm and disc connect or on lateral side of disc (Figure 1.4).
Girdle belts	Encircling or ring-like structure of tentacle scales or fine arm spines arranged in belts encircling arm; also see belts of hooks.
Glassy	Almost transparent, glossy or shiny.
Hyaline	Clear or transparent.
Imbricating	Structures overlapping.
Infra-	Prefix, down, below, beneath.
Infradental papillae	Papillae situation in front, just below oral papillae but not on apex of jaw (Figure 1.4).
Inter-	Prefix, among or between.
Interradial area	Area between arms on disc, found both dorsally and ventrally.
Interstitial	Small spaces between.
Jaws	Mouth parts containing oral papillae, teeth and oral tentacle scales. Also see oral plates (Figure 1.4).
Lacking	Non-existent, absent.
Lamina	Inner side of hooks or hooklets on arm spine, present in Euryalida (Figure A1).
Lateral	Situated at, coming from, or directed towards.
Lateroventral	Situated to a side and below or underside.
Lobe	Round protrusion from a surface (Figure A2).
Lowermost (referring to teeth)	Position when ventral side is being examined, lowermost tooth is closest tooth while uppermost tooth is deep in mouth.
Madreporite	Perforated plate by which entry of seawater into vascular system is controlled.
Marbled	Streaked, patterned or variegated in appearance.
Marginal scales	Scales or plates on disc margin.
Median projection	Protrusion in middle.
Monoliliform	Beaded appearance.
Multifid	End or tip of a structure, has multiple protrusions, divisions or tips; also see multi-toothed (Figure A3).
Multi-toothed	End or tip of a structure, has multiple protrusions, divisions or tips; also see multifid (Figure A3).
Notch	Indentation on edge or surface of a structure (Figure A2).
Opaque	Structure not being translucent or clear.
Opercular	Flap-like or broad in shape.
Oral	Lower or underside of an organism or pertaining to area close to mouth. Also see ventral and adoral.
Oral bridge	Structure joining two lateral sides of vertebrae in arms.
Oral frame	Outer edges of jaws.
Oral papillae	Papillae fringing jaws, may be one or few (Figure 1.4).
Oral plates	Mouth parts containing oral papillae, teeth and oral tentacle scales, used interchangeably with the term jaws.
Oral shield	Single plate on each jaw, adjacent to adoral shields.
Oral slit	Mouth or opening on ventral side.
Oral tentacle pore	Pore in oral / jaw area from which tube feet arise (Figure 1.4).
Oral tentacle scales	Single or sometimes paired papillae adjacent to first one or two tentacle / oral pores, more or less inset into oral slit, sometimes in series with or may be indistinguishable from oral papillae.
Ossicles	Small calcified structures referred to in Euryalida structures.
Papilla	Nipple-like elevation or feature.
Papilliform	Shape of nipple-like structures.
Paved	Where plates cover a surface or interlocking without gaps or overlapping.
Plates	Flat structures used in creating a feature, for reinforcement or protection; also see shields and scales.

Polygonal	Two dimensional shapes formed with straight lines.
Primary rosette	Group of five primary radial plates and central plate on dorsal side of disc (Figure 1.3).
Proximal	Toward or nearer centre of body; see also basal (Figure A1).
Pustular	Small swelling or slightly enlarged structure at tip of a structure, similar to clavate or club.
Pyriform	Pear-shaped (Figure A2).
Radial plates	Primary plates located in centre of disc, not to be confused with radial shields which are located at disc margin.
Radial shields	Pair of plates on dorsal side of disc opposite base of each arm, may be reduced or concealed by disc armament. In Euryalida, may be rib-like and sometimes referred to as radial ribs (Figure 1.2).
Rudimentary	Immature, undeveloped or basic form.
Rugose	Structure being corrugated or rough.
Scales	Flat structures used in reinforcement, protection or creating structure; also see shields and plates.
Secondary tooth	Secondary hook on arm spines where end has more than a single hook (Figure A1).
Segment	External structure of arm vertebrae.
Shields	Flat structures used in reinforcement, protection or creating structure; also see plates and scales.
Simple	Arms not branched or do not split.
Sinuous	Having many curves and turns.
Spines	Projections and protrusions which are fleshy or spiny, usually hosted by lateral arm plates but spines also occur on disc.
Spinelets	Small spines.
Spiniform	Narrow and elongated, may diminish or reduce in thickness towards one end; also see tapering (Figure A2).
Squat	Short and wide.
Stereotropism	Growth or movement determined by contact with a solid.
Stout	Thick and visibly strong.
Striations	Series of ridges, furrows or linear marks.
Subcutaneous	Under skin.
Subequal	Nearly equal in length.
Superimposed	Placed or laying over another, usually so both structures are still evident.
Supplementary plates / shields	Additional plates adjacent to dorsal disc plates or scales, oral shields or arm plates, only found in some families or genera.
Tapering	Diminishes or reduces in thickness towards one end; also see spiniform (Figures A2 & A3).
Teeth	Structures on jaws, may be placed on dental plate or on apex of jaws (Figure 1.4).
Tentacle pore	Pore from which tube feet arise (Figure 1.4).
Tentacle scale	Papillae adjacent to tentacle pores, may cover tentacle pore (Figure 1.4).
Terminal tooth	Primary hook on arm spines. Arm spines may have more than a single hook (Figure A1).
Tessellated	Repeated use of a single shape, without gaps or overlapping.
Tinge	Trace of a colour.
Trefoil	Three-lobed (Figure A2).
Trifid	Three points, parts or branches (Figure A3).
Truncated	Abrupt termination or square end of a structure.
Tube feet	Appendages at end of water vascular system, project through tentacle pores.
Tumid	Puffy, swollen, enlarged, bulging.
Umbrella	Fringe of modified arm segments, only found in *Astrophiura*.
Undulating	Wavy form or outline.
Ventral groove	Furrow along midline of ventral arm.

Ventral	Lower or underside of an organism.
Vertebrae	Individual segments in arms.
Wanting	Lacking, being non-existent or absent.

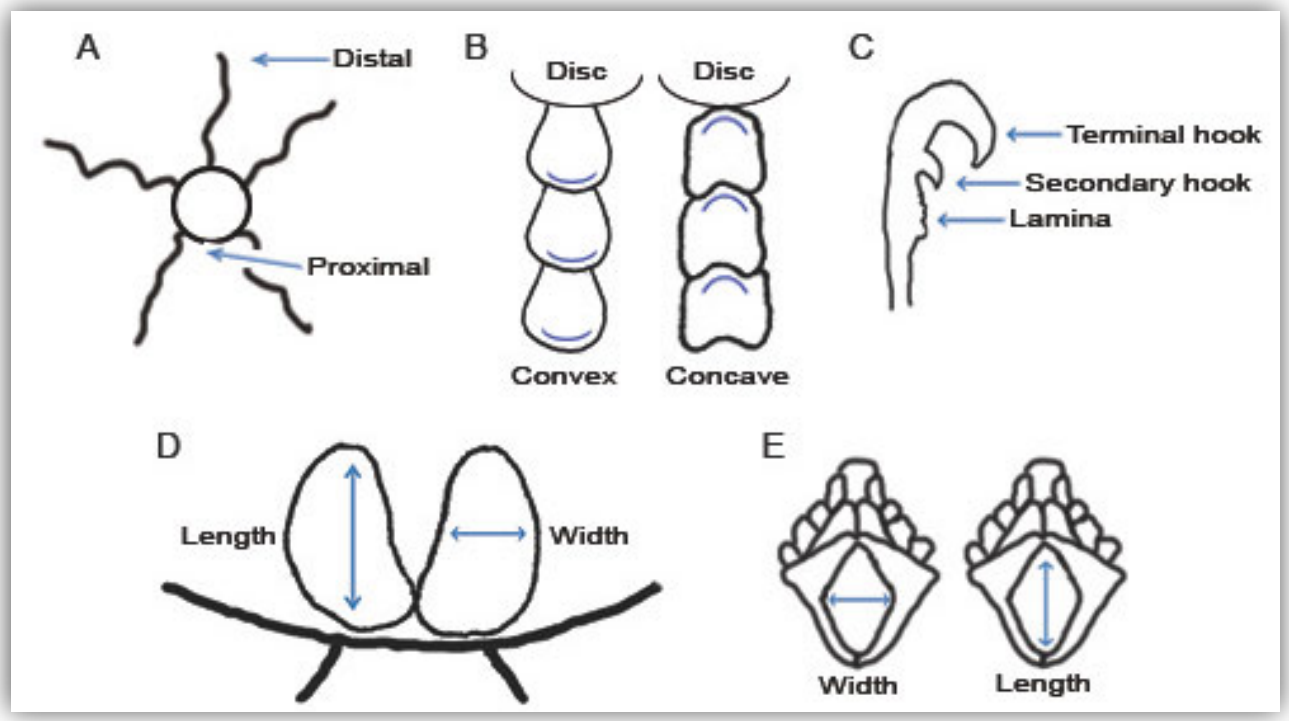

Figure A1. Terms describing various positions, placement and directionality. A) Whole specimen showing distal and proximal positions in relation to body of the Ophiuroidea; B) Two arms, showing arm plates that are distally convex and distally concave in relation to the disc; C) Hook showing placement of terminal tooth, secondary tooth and lamina; D) Radial shields and their directionality; E) Oral shields and their directionality.

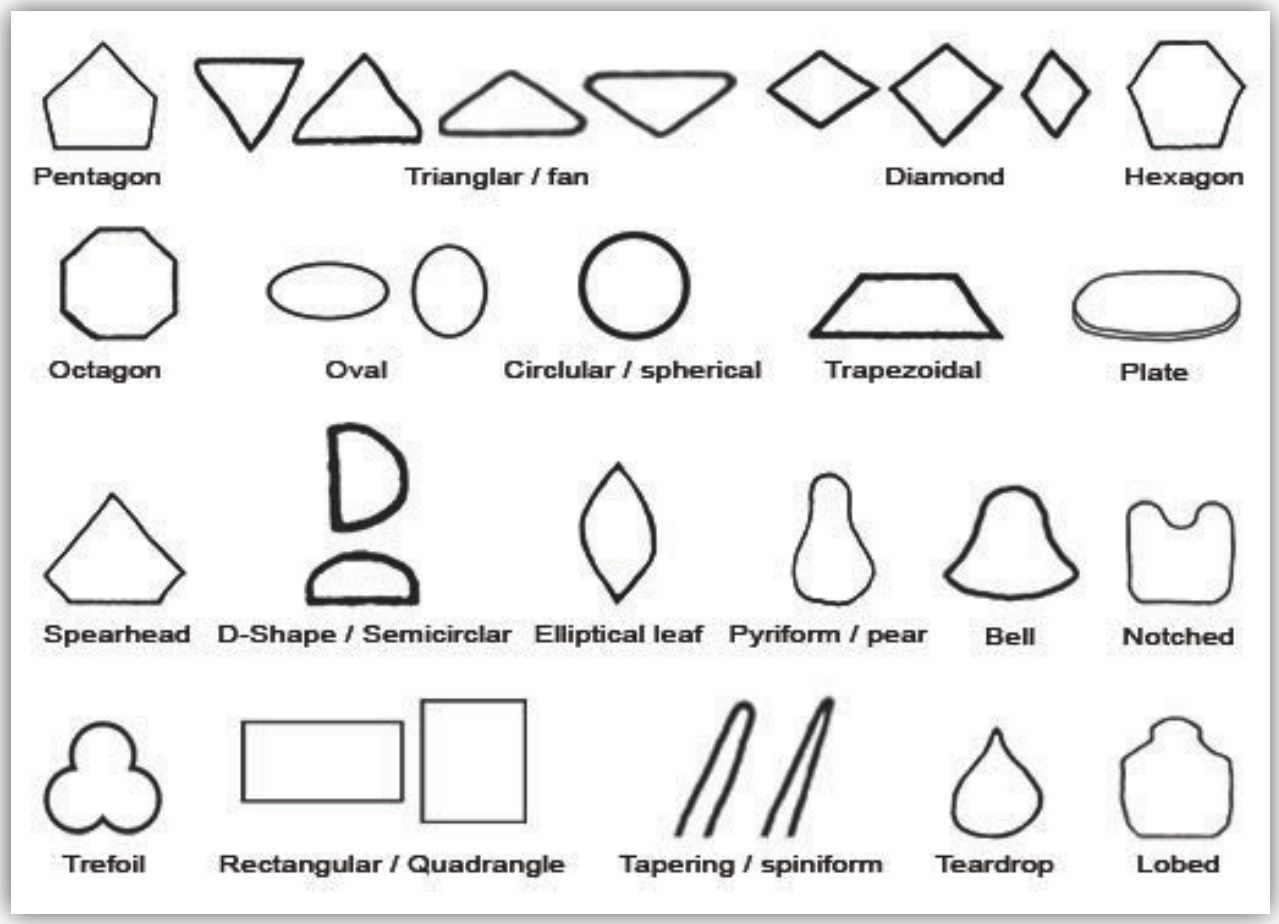

Figure A2. Terms describing various shapes of plates, shields and papillae used during a study on the taxonomy, biodiversity and biogeography of the Ophiuroidea of South Africa.

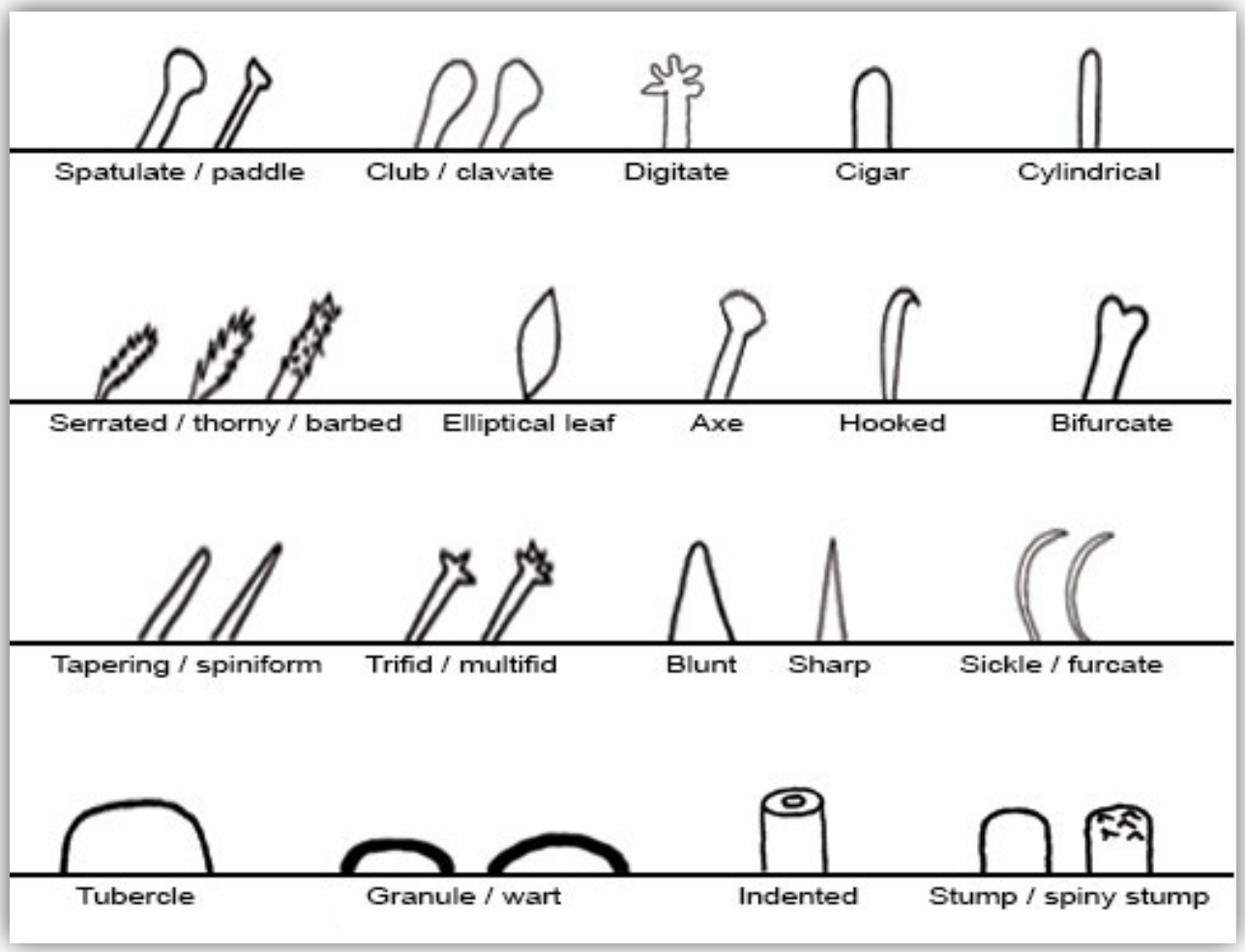

Figure A3. Terms describing various disc armament, arm spines and protrusions used during a study on the taxonomy, biodiversity and biogeography of the Ophiuroidea of South Africa.

Appendix B. Checklist of all Ophiuroidea species known for South Africa, including recorded range extensions, endemic species, species new to South Africa and species which have had taxonomic revisions since Clark and Courtman-Stock (1976).

Taxon	Range extension	Endemic	New to South Africa	Nomenclature changes
EURYALIDA Lamarck, 1816				
Asteroschematidae Verrill, 1899				
Asteroschema salix Lyman, 1879			X	
Euryalidae (Gray, 1840)				
Asteromorpha capensis (Mortensen, 1925)				X
Asterostegus tuberculatus Mortensen, 1933				
Astroceras spinigerum Mortensen, 1933				
Asteronychidae Verrill, 1899				
Asteronyx loveni Müller & Troschel, 1842				
Gorgonocephalidae Ljungman, 1867				
Astroboa nuda (Lyman, 1874)			X	
Astrocladus africanus Mortensen, 1933				
Astrocladus euryale (Retzius, 1783)		X		
Astrocladus hirtus Mortensen, 1933		X		
*Astrodendrum capensis (*Mortensen 1933)	X			X
Astroglymma cf. *sculptum* (Döderlein, 1896)			X	
Astrothorax waitei (Benham, 1909)				X
Gorgonocephalus chilensis (Philippi, 1858)	X			
Gorgonocephalus pustulatum (H.L. Clark, 1916)				X
OPHIURIDA Müller and Troschel, 1840				
Ophiomyxidae Ljungman, 1867				
Ophiomyxa australis Lütken, 1869			X	
Ophiomyxa bengalensis Koehler, 1897				
Ophiomyxa tenuispina Mortensen, 1933		X		
Ophiomyxa vivipara capensis Mortensen, 1936		X		
Ophiolycus dentatus (Lyman, 1878)				X

Ophioscolex inermis Mortensen, 1933		X		X
Ophiuridae Lyman, 1865				
Ophiernus quadrispinus Koehler, 1908				X
Ophiernus vallincola Lyman, 1878				X
Ophiopallas paradoxa Koehler, 1904				
Amphiophiura sculptilis (Lyman, 1878)			X	
Amphiophiura trifolium Hertz, 1927				
Astrophiura permira Sladen, 1879				
Ophiocten affinis simulans (Mortensen, 1936)		X		X
Ophiocten amitinum Lyman, 1878				
Ophiocten hastatum Lyman, 1878				
Ophiomisidium pulchellum (Wyville Thomson, 1878)	X			
Ophiura flagellata (Lyman, 1878)				X
Ophiura kinbergi Ljungman, 1867	X			X
Ophiura ljungmani (Lyman, 1878)				
Ophiura (Dictenophiura) anoidea Clark, 1923		X		X
Ophiura (Ophiura) trimeni Bell, 1905	X	X		
Ophiura (Ophiuroglypha) costata costata (Lyman, 1878)		X		
Ophiura (Ophiuroglypha) costata tumida Mortensen, 1933				
Ophiura (Ophiuroglypha) irrorata irrorata (Lyman, 1878)				X
Ophiura (Ophiuroglypha) schmidtotti (Hertz, 1927)				
Amphilepididae Matsumoto, 1915				
Amphilepis scutata Mortensen, 1933		X		X
Amphilimna cribriformis A.M. Clark, 1974				X
Amphilimna valida (H.L. Clark, 1939)				X
Amphiuridae Ljungman, 1867				
Amphioplus (Amphioplus) pectinatus Mortensen, 1933		X		
Amphioplus (Lymanella) depressus (Ljungman, 1867)				
Amphioplus (Lymanella) furcatus Mortensen, 1933				

Amphioplus (Lymanella) integer (Ljungman, 1867)					
Amphioplus (Unioplus) falcatus Mortensen, 1933		X			
Amphipholis similis Mortensen, 1933	X	X			
Amphipholis squamata (Delle Chiaje, 1828)					
Amphipholis strata Mortensen, 1933		X			
Amphiura (Amphiura) acutisquama A.M. Clark, 1952	X	X			
Amphiura (Amphiura) albella Mortensen, 1933	X	X			
Amphiura (Amphiura) angularis Lyman, 1879					
Amphiura (Amphiura) atlantica Ljungman, 1867	X				
Amphiura (Amphiura) capensis Ljungman, 1867	X				
Amphiura (Amphiura) grandisquama natalensis Mortensen, 1933	X	X			
Amphiura (Amphiura) incana Lyman, 1879	X				
Amphiura (Amphiura) linearis Mortensen, 1933		X			
Amphiura (Amphiura) otteri Ljungman, 1872					
Amphiura (Amphiura) simonsi A.M. Clark, 1952		X			
Amphiura (Amphiura) uncinata Koehler, 1904					
Ophiodaphne scripta (Koehler, 1904)	X				X
Ophionephthys lowelli A.M. Clark, 1974		X			
Ophiactidae Matsumoto, 1915					
Histampica duplicata (Lyman, 1875)					
Ophiactis abyssicola (M. Sars, 1861)					
Ophiactis carnea Ljungman, 1867					
Ophiactis nidarosiensis Mortensen, 1920					
Ophiactis cf. *picteti* (de Loriol, 1893)			X		
Ophiactis plana Lyman, 1869					
Ophiactis savignyi (Müller & Troschel, 1842)					
Ophiocomidae Ljungman, 1867					
Ophiocoma (Breviturma) brevipes Peters, 1851			X	X	
Ophiocoma (Breviturma) dentata Müller & Troschel, 1842			X	X	

Ophiocoma (Breviturma) doederleini de Loriol, 1899			X	X
Ophiocoma erinaceus Müller & Troschel, 1842	X			
Ophiocoma pica Müller & Troschel, 1842	X			
Ophiocoma pusilla (Brock, 1888)			X	
Ophiocoma scolopendrina (Lamarck, 1816)	X			
Ophiocoma valenciae Müller & Troschel, 1842				
Ophiocomella sexradia (Duncan, 1887)			X	
Ophiomastix koehleri Devaney, 1977			X	
Ophiomastix venosa Peters, 1851			X	
Ophiopsila bispinosa A.M. Clark, 1974		X		
Ophiopsila seminuda A.M. Clark, 1952				
Ophionereididae Ljungman, 1867				
Ophionereis australis (H.L. Clark, 1923)				
Ophionereis dubia dubia (Müller & Troschel, 1842)	X			
Ophionereis porrecta Lyman, 1861				
Ophionereis vivipara Mortensen, 1933				
Ophiotrichidae Ljungman, 1867				
Macrophiothrix demessa (Lyman, 1862)			X	
Macrophiothrix hirsuta cheneyi (Lyman, 1862)				
Macrophiothrix longipeda (Lamarck, 1816)				
Macrophiothrix propinqua (Lyman, 1862)			X	X
Ophiocnemis marmorata (Lamarck, 1816)				
Ophiogymna capensis (Lütken, 1869)		X		
Ophiogymna fulgens (Koehler, 1905)				
Ophiothela danae Verrill, 1869				
Ophiothela venusta (de Loriol, 1900)				X
Ophiothrix (Acanthophiothrix) proteus Koehler, 1905				
Ophiothrix (Acanthophiothrix) purpurea von Martens, 1867			X	
Ophiothrix (Ophiothrix) aristulata Lyman, 1879				

Ophiothrix (Ophiothrix) echinotecta Balinsky, 1957			X		
Ophiothrix (Ophiothrix) foveolata Marktanner, 1887			X		
Ophiothrix fragilis (Abildgaard, in O.F. Müller, 1789)					
Ophiothrix fragilis var. *triglochis* (Müller and Troschel, 1842)		X			
Ophiacanthidae Ljungman, 1867					
Ophiacantha baccata Mortensen, 1933					
Ophiacantha nerthepsila H.L. Clark, 1923	X	X			
Ophiacantha scutigera Mortensen, 1933	X	X			
Ophiacantha striolata Mortensen, 1933		X			
Ophiolimna perfida (Koehler, 1904)					
Ophiomitrella corynephora H.L. Clark, 1923	X	X			
Ophiomitrella hamata Mortensen, 1933		X			
Ophiophthalmus relictus (Koehler, 1904)					
Ophioplinthaca papillosa H.L. Clark, 1939					
Ophioplinthaca rudis (Koehler, 1897)					
Ophioplinthaca sexradia Mortensen, 1933		X			
Ophiothamnus remotus Lyman, 1878		X			
Ophiotoma cf. *alberti* (Koehler, 1896)			X		
Ophiotoma cf. *gracilis* (Koehler, 1914)			X		
Ophiotreta durbanensis (Mortensen, 1933)		X			
Ophiotreta matura (Koehler, 1904)					
Ophiodermatidae Ljungman, 1867					
Cryptopelta aster (Lyman, 1879)		X			
Ophiochaeta hirsuta Lütken, 1869			X		
Ophioconis cupida Koehler, 1905			X		
Ophiodyscrita acosmeta H.L. Clark, 1938			X		
Ophiopeza fallax fallax Peters, 1851	X			X	
Ophiopeza spinosa (Ljungman, 1867)			X		
Ophiarachna affinis Lütken, 1869			X		

Ophiarachnella capensis (Bell, 1888)	X			
Ophiarachnella gorgonia (Müller & Troschel, 1842)			X	
Ophiarachnella septemspinosa (Müller & Troschel, 1842)			X	
Ophiochasma nitida Hertz, 1927		X		
Ophioderma wahlbergii Müller & Troschel, 1842				
Ophiolepididae Ljungman, 1867				
Anophiura simplex H.L. Clark, 1939				X
Aspidophiura corone Hertz, 1927				X
Ophiolepis cincta cincta Müller & Troschel, 1842				X
Ophiomusium lymani Wyville Thomson, 1873	X			X
Ophioplocus imbricatus (Müller & Troschel, 1842)			X	X

Appendix C. Accession numbers and sampling details of photographed specimens used in Chapter 6 on the taxonomy, biodiversity and biogeography of the Ophiuroidea of South Africa. Accession numbers listed in alphabetical order. Photographed specimens not within the EEZ of mainland South Africa are marked with an asterisk.

Accession number and sampling detail	Species
DNSM ECH1, -29.3874°, 31.6509°, 18-20 miles off Umvoti River Mouth, depth 110-132m, 1 November 1920, holotype.	*Asteromorpha capensis*
DNSM ECH21B, -34.6000°, 17.0000°, Cape Town, depth unknown, 1 February 1964.	*Ophiactis carnea*
DNSM ECH23B, -29.7765°, 31.0567°, north of Durban, depth unknown.	*Ophiactis plana*
DNSM ECH23E, -29.7765°, 31.0567°, north of Durban, depth unknown.	*Amphioplus (Lymanella) integer*
DNSM ECH26, -31.4340°, 29.8220°, Waterfall Bluff, Eastern Cape, depth 63-91m, 1 April 1921.	*Ophiomitrella hamata*
EKZNW AS_2_JMO_2008, -30.2669°, 30.8001°, Aliwal Shoal, depth 17m, 14 June 2008.	*Ophionereis porrecta*
EKZNW LSS_4_EKZNW, -27.8667°, 32.6000°, Leadsman Shoal, depth 11m, 13 October 2010.	*Ophiarachnella septemspinosa*
EKZNW RR_4_JMO_2010, -29.9861°; 30.9645°, Reunion Rocks, depth intertidal, 24 September 2010.	*Ophiocomella sexradia*
RBINS (unaccessioned), 2-mile reef, pinnacles -27.5193°, 32.6867°, 15.4m, Belgian/South African Echinoderm Expedition, RSAKZN/2016.008, 9 January 2016.	*Ophiocoma erinaceus*
RMCA MT1496, -4.6667°; 55.4666°, Mahé, Seychelles, Mission Zoologique MRAC-ULB, 7 August 1972.*	*Ophiocoma pica*
RMCA MT1566, -26.0167°, 32.9000°, Inhaca, Mozambique, Mission Zoologique MRAC-ULB, 7 August 1969.*	*Ophiura kinbergi*
RMCA MT1708, -12.2500°, 43.7500°, Grande Comore, Moroni, Comoros, 17 August 1981.*	*Ophiocoma scolopendrina*
RMCA MT1750, -27.4504°, 32.7129°, 5-mile Reef, Sodwana Bay, depth 18m, Belgian/South African Echinoderm Expedition, 8 April 1999.	*Ophiocoma valenciae*
RMCA MT2144, -26.9335°; 32.8871°, Bhanga Nek, depth 20m, Belgian/South African Echinoderm Expedition, 14 August 1999.	*Ophiarachnella gorgonia*
RMCA MT2153, -30.2637°, 30.8264°, Aliwal Shoal, depth 13m, Belgian/South African Echinoderm Expedition, 4 August 1999.	*Ophiocoma pusilla*
RMCA MT2156, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 13m, Belgian/South African Echinoderm Expedition, 4 September 1999.	*Macrophiothrix demessa*
RMCA MT2160, -27.5227°, 32.6919°, Ribbon Reef, Sodwana Bay, depth 20m, Belgian/South African Echinoderm Expedition, 14 August 1999.	*Macrophiothrix longipeda*
RMCA MT2174, -27.4132°, 32.7268°, Sodwana Bay, 9-mile Reef, depth 18m, Belgian/South African Echinoderm Expedition, 12 August 1999.	*Ophiothrix (Ophiothrix) foveolata*
RMCA MT2183, -27.4472°, 32.7167°, Sodwana Bay, 7-mile Reef, depth 23m, Belgian/South African Echinoderm Expedition, August 2000.	*Ophiodyscrita acosmeta*
RMCA MT2185, -27.5227°, 32.6919°, Sodwana Bay, depth 12m, Belgian/South African Echinoderm Expedition, 8 April 1999.	*Ophiothrix (Acanthophiothrix) purpurea*
RMCA MT2186, -27.5227°, 32.6919°, Sponge Reef, Sodwana Bay, depth 30m, Belgian/South African Echinoderm Expedition, 15 August 1999.	*Astrocladus hirtus*
RMCA MT2194, -27.3350°, 32.7527°, Mabibi, depth 16m, Belgian/South African Echinoderm Expedition, 16 August 1999.	*Ophiocoma (Breviturma) brevipes*
RMCA MT2213, -30.2637°, 30.8264°, Aliwal Shoal, depth 14-18m, Belgian/South African Echinoderm Expedition, 3 August	*Ophiothela venusta*

1999.	
RMCA MT2216, -27.5227°, 32.6919°, Sodwana Bay, depth unknown, Belgian/South African Echinoderm Expedition, 10 April 1999.	*Macrophiothrix propinqua*
RMCA MT2249, -26.9335°, 32.8871°, Bhanga Nek, depth 20m, Belgian/South African Echinoderm Expedition, 3 August 1999.	*Ophiocoma (Breviturma) doederleini*
RMCA MT2250, -27.5227°, 32.6919°, 2-mile Reef, Sodwana Bay, depth 15m, Belgian/South African Echinoderm Expedition, 3 August 1999.	*Ophiocoma (Breviturma) doederleini*
RMCA MT2251, -26.9335°, 32.8871°, Bhanga Nek, depth 16m, Belgian/South African Echinoderm Expedition, 15 August 1999.	*Ophiopeza fallax fallax*
RMCA MT2257, -27.9335°, 32.8871°, Bhanga Nek, depth 20m, Belgian/South African Echinoderm Expedition, 14 August 1999.	*Ophiothrix (Ophiothrix) echinotecta*
RMCA MT2259, -30.2637°, 30.8264°, Aliwal Shoal, depth 14-18m, Belgian/South African Echinoderm Expedition, 8 August 1999.	*Ophiactis savignyi*
RMCA MT2274, -27.5227°, 32.6919°, Sodwana Bay, 2-mile Reef, depth 13m, Belgian/South African Echinoderm Expedition, 9 August 1999.	*Ophiomyxa australis*
RMCA MT2284, -26.9335°; 32.8871°, Bhanga Nek, depth 20m, Belgian/South African Echinoderm Expedition, 14 August 1999.	*Ophiopeza spinosa*
RMCA MT2290, -27.5227°, 32.6919°, Sodwana Bay, depth 8-24m, Belgian/South African Echinoderm Expedition, August 1999.	*Ophiochaeta hirsuta*
RMCA MT2306, -27.6180°, 32.6880°, Sodwana Bay, depth 10m, Belgian/South African Echinoderm Expedition, July 2000.	*Ophioplocus imbricatus*
RMCA MT2311, -27.5227°, 32.6919°, 1/4-mile Reef, Sodwana Bay, depth 29m, Belgian/South African Echinoderm Expedition, 16 August 1999.	*Ophiodaphne scripta*
RMCA MT2316, -27.5227°, 32.6919°, 2-mile Reef, Sodwana Bay, depth unknown, Belgian/South African Echinoderm Expedition, 24 July 2000.	*Ophiolepis cincta cincta*
RMCA MT2333, -26.9335°, 32.8871°, Bhanga Nek, depth 43m, Belgian/South African Echinoderm Expedition, 19 June 1999.	*Macrophiothrix hirsuta cheneyi*
RMCA MT2353, -27.5227°, 32.7129°, Sodwana Bay, depth 21m, Belgian/South African Echinoderm Expedition, 7 November 2003.	*Ophiomastix venosa*
RMCA MT2356, -27.5227°, 32.7129°, Ribbon Reef, Sodwana Bay, depth 21m, Belgian/South African Echinoderm Expedition, 7 November 2003.	*Ophiothela venusta*
RMCA MT2360, -27.5227°, 32.7129°, Ribbon Reef, Sodwana Bay, depth 21m, Belgian/South African Echinoderm Expedition, 7 November 2003.	*Ophionereis dubia dubia*
RMCA MT2380, -26.9335°, 32.8871°, Sodwana Bay, depth 20m, Belgian/South African Echinoderm Expedition, 4 July 2003.	*Ophiocoma (Breviturma) dentata*
RMCA MT2510, -27.5258°, 32.6881°, Chain Reef, Sodwana Bay, depth unknown, Belgian/South African Echinoderm Expedition, 6 November 2003.	*Ophiocnemis marmorata*
SAMC A073830, -32.6296°, 16.6468°, St Helena Bay, depth 440m, Lara Atkinson, 9 April 2007.	*Amphiura (Amphiura) acutisquama*
SAMC A073832, -30.7020°, 15.4412°, depth 349m, Lara Atkinson, 4 April 2007.	*Amphipholis strata*
SAMC A073834, -32.6296°, 16.6468°, St Helena Bay, depth 440m, Lara Atkinson, 9 April 2007.	*Amphilepis scutata*

SAMC A073875, -36.2166°, 20.1197°, depth 187m, station number, 7001-3028 A32294, 26 April 2012.	*Ophiothamnus remotus*
SAMC A081578, -27.3399°, 32.7568°, Mabibi Reef, depth 20.8m, Belgian/South African Echinoderm Expedition, 2 February 2016.	*Astroboa nuda*
SAMC A081608, Leadsman Shoal, -27.8736°, 32.6036°, 10.5m, Belgian/South African Echinoderm Expedition, 2 February 2016.	*Ophiarachnella gorgonia*
SAMC A082574, -30.9385°, 16.6333°, depth 337m, station number 86, Lara Atkinson, 2 February 2013.	*Ophiomyxa vivipara capensis*
SAMC A084226, -33.9690°, 18.3700°, Oudekraal, Cape Peninsula, depth intertidal, 28 July 1934.	*Amphiura (Amphiura) capensis*
SAMC A084227, -34.6167°, 25.2500°, off St Francis Bay, depth 450m, *Africana,* station number A7164-063-046-4197, 22 May 1988.	*Gorgonocephalus pustulatum*
SAMC A084228, -34.6702°, 20.2353°, Ariston, depth intertidal, UCT Ecological Survey Collection, station number AR7H, 23 November 1939.	*Ophiarachnella capensis*
SAMC A084229, -30.7011°, 15.4410°, depth 349m, 4 April 2007.	*Amphiura (Amphiura) atlantica*
SAMC A084230, Dorsal: FAL434C, -34.2530°, 18.5500°, False Bay, depth 9m, UCT Ecological Survey Collection, station number FAL 434C, 25 October 1961.	*Ophiopsila seminuda*
SAMC A084231, Ventral: -34.1580°, 18.5830°, False Bay, depth 35m, UCT Ecological Survey Collection, station number FAL 5M, 22 February 1952.	*Ophiopsila seminuda*
SAMC A084232, -34.6330°, 19.2974°, Danger Point, depth intertidal, UCT Ecological Survey Collection, station number DP 1B, 5 July 1939.	*Ophioderma wahlbergii*
SAMC A084233, -29.4583°, 31.8795°, Tinley Manor, depth 240m, Oceanographic Research Institute, ACEP II, ECH 17-04/09 (ACEP 108)_3, 17 August 2010.	*Ophiomyxa bengalensis*
SAMC A084234, -34.3670°, 18.5870°, False Bay, depth 73m, 11 September 1953, UCT Ecological Survey Collection, station number FAL185P, 11 September 1953.	*Ophiocten amitinum*
SAMC A084235, -34.1000°, 18.7000°, False Bay, depth unknown, UCT Ecological Survey Collection, station number FAL 618Y, 20 February 1964.	*Ophiacantha nerthepsila*
SAMC A084236, -34.1333°, 18.5168°, False Bay, depth 27-28m, UCT Ecological Survey Collection, station number FB 105 6C, 22 February 1947.	*Amphiura (Amphiura) simonsi*
SAMC A084237, -27.7686°, 14.6990°, Benguela upwelling system, Namibia, NAM T1, depth 408m, 1 April 2007.	*Ophiura (Ophiura) trimeni*
SAMC A084239, Boteler Point, -27.0333°, 32.8616°, depth intertidal, J.L.B. Smith Institute, station number RW 76-23_2, 30 July 1976.	*Amphipholis squamata*
SAMC A084240, -31.0000°, 30.4500°, off Glenmore, depth 900m, *Meiring Naude,* station number SM134, 12 May 1977.	*Gorgonocephalus chilensis*
SAMC A084241, -32.2501°, 29.1501°, Mbashe River Mouth, depth 600-650m, *Meiring Naude,* station number SM 237, 25 June 1979.	*Ophiacantha striolata*
SAMC A084242, -34.0201°, 23.9039°, Storm's River Mouth, depth intertidal.	*Ophiothrix fragilis* var. triglochis
SAMC A084243, -34.6335°, 19.2500°, off Danger Point, depth 30m, *TB Davie,* station number TBD 511 (7172-D), 10 February 1988.	*Astrocladus euryale*
SAMC A084244, -32.0830°, 17.8660°, Lamberts Bay, depth 123m, UCT Ecological Survey Collection, station number TRA 74L, 5 February 1953.	*Ophiura (Dictenophiura) anoidea*
SAMC A084245, -30.0835°, 31.0500°, Kingsburgh, depth 300-305m, *Meiring Naude*, station number XX 66, 9 July 1985.	*Ophiacantha baccata*
SAMC A084246, -30.0686°, 31.0508°, Amanzimtoti, depth 300-305m, *Meiring Naude,* station number XX 66, 9 July 1985.	*Ophiomisidium pulchellum*

SAMC A088277, -30.0011°, 31.0500°, Isipingo, depth 100m, *Meiring Naude,* station number XX76, 10 July 1985.	*Ophionereis australis*
SAMC A088480, -34.6830°, 21.3161°, depth 68m, Lara Atkinson, 16 April 2015.	*Ophiothrix fragilis*
SAMC A088481, -30.9252°, 15.7182°, off Groen River mouth, depth 284-320m, *Ellen,* station number CBS009, 30 January 2016.	*Astrodendrum capensis*
SAMC A22013, -33.8117°, 16.5000°, off Cape Town, depth 2730m, *Africana II*, station number A193, 27 August 1959.	*Asteronyx loveni*
SAMC A22018, -33.8116°, 16.5000°, off Saldanha Bay, depth 2730m, *Africana II,* station number A193, 27 August 1959.	*Ophiernus quadrispinus*
SAMC A22044, -33.8666°, 16.8500°, Table Bay, depth 2511-2766m, *Africana II,* station number A 318, 9 December 1959.	*Ophiomusium lymani*
SAMC A22100, -34.6000°, 17.0000°, off Cape Town, depth 2730m, *Africana II,* station number A322, 10 December 1959.	*Amphiura (Amphiura) otteri*
SAMC A22103, -34.6166°; 17.0500°, off Cape Town, depth 2875-2948m, *Africana II*, station number A315, 8 December 1959.	*Ophiotoma cf. gracilis*
SAMC A22112, -33.8116°; 16.5000°, off Saldanha Bay, depth 2730m, *Africana II*, station number A193, 27 August 1959.	*Ophiotoma cf. alberti*
SAMC A22370, -29.8770°, 31.1940°, Bluff, Durban, depth 232m, *Pickle*.	*Ophiura (Ophiuroglypha) costata tumida*
SAMC A22781, -32.5505°; 28.6352°, NE of East London, depth 55m, South Coast Dredging Programme, station number SCD74S, 16 July 1959.	*Ophionephthys lowelli*
SAMC A22787, -29.4833°, 31.7500°, NE of Durban, depth 86m, Natal Museum Dredging Programme, station number NAD52E, 9 September 1964, paratype.	*Amphilimna cribriformis*
SAMC A22793, -29.5833°, 31.7000°, north of Tongaat beach, depth 138m, Natal Dredging Programme, station number NAD46C, holotype (ventral).	*Ophiopsila bispinosa*
SAMC A22794, -29.4333°, 33.0500°, Umhlali, depth 77m, Natal Dredging Programme, station number NAD58A, paratype, (dorsal).	*Ophiopsila bispinosa*
SAMC A22797, -27.7334°, 32.7002°, south of Sodwana Bay, depth 400-450m, *Meiring Naude, s*tation number SM23, 26 May 1976.	*Ophiotreta durbanensis*
SAMC A22801, -27.5500°, 32.7433°, off Sodwana Bay, depth 376-384m, *Meiring Naude*, station number SM16.	*Ophiopallas paradoxa*
SAMC A22811, -28.3502°, 32.9001°, St Lucia, depth 775-825m, *Meiring Naude,* station number SM38, 28 May 1976.	*Ophiura (Ophiuroglypha) schmidtotti*
SAMC A22913, -28.6300°, 32.6400°, north of Nhlabane estuary, depth 1000-1200m, *Meiring Naude,* station number SM 107, 25 May 1976.	*Ophioplinthaca rudis*
SAMC A22918, -28.6300°, 32.6400°, north of Nhlabane estuary, depth 1000-1200m, *Meiring Naude,* station number SM 107, 25 May 1976.	*Ophioplinthaca papillosa*
SAMC A22919, -27.5183°, 32.8333°, north of Leven Point, depth 780m, *Meiring Naude,* station number SM 77, 21 May 1976.	*Ophiotreta matura*
SAMC A22929, -28.6168°, 32.6334°, north of Nhlabane estuary, depth 1000-1200m, *Meiring Naude*, station number SM 107, 25 May 1976.	*Ophiophthalmus relictus*
SAMC A22936, -27.5183°, 32.8333°, Sodwana Bay, depth 780m, *Meiring Naude,* station number SM 77, 21 May 1976.	*Ophiolimna perfida*
SAMC A22938, -27.9834°, 32.6668°, off Leven Point, depth 550m, *Meiring Naude*, station number SM 86.	*Amphiura (Amphiura) albella*
SAMC A22947, -28.5168°, 32.5667°, Cape St Lucia, depth 680m, *Meiring Naude,* station number SM103, 24 May 1976.	*Histampica duplicata*
SAMC A22954, -26.8500°, 33.2000°, off Kosi Bay, depth 720m, *Meiring Naude,* station number SM 53, 18 May 1976.	*Anophiura simplex*
SAMC A22955, -27.1516°, 32.9672°, off Black Rock, depth 800-810m, *Meiring Naude*, station number SM 60, 19 May 1976.	*Aspidophiura corone*

SAMC A23217, -24.2000, 36.0167, Mozambique, depth 1140m, *Anton Bruun*, station number ABD 7C, 17 August 1974.	*Amphiophiura trifolium*
SAMC A23219, -29.1700°, 31.6700°, Amatikulu, depth 33m, *Anton Bruun*, station number 356C, 29 July 1964.	*Amphioplus (Lymanella) furcatus*
SAMC A23220, -29.4833°, 31.7500°, Sheffield Beach, depth 86m, Natal Dredging Programme, station number NAD 55D, 9 September 1964.	*Amphioplus (Amphioplus) pectinatus*
SAMC A23229, -29.7000°, 31.6333°, off Umhlanga, depth 350m, *Anton Bruun,* station number ABD 15E, 8 September 1964.	*Amphiura (Amphiura) uncinata*
SAMC A23231, -29.7000°, 31.6333°, off Umhlanga, depth 350m, *Anton Bruun,* station number ABD15D, 8 September 1964	*Amphilimna valida*
SAMC A23233, -25.1167°, 34.5667°, Mozambique, depth 112m, 19 August 1964.*	*Astroceras spinigerum*
SAMC A23236, -34.0500°, 25.9833°, Port Elizabeth, depth 84m, South Coast Dredging Programme, station number SCD 155A, 25 November 1960.	*Cryptopelta aster*
SAMC A23238, -31.2500°, 16.0000°, Gysobay, depth 415m, 24 September 1952.	*Ophiactis abyssicola*
SAMC A23252, -30.0333°, 15.0333°, Noup, depth 364m, 21 August 1947.	*Ophiomitrella corynephora*
SAMC A23259, Jangamo Reef, Mozambique, depth unknown, 8 July 1968.*	*Ophiothela danae*
SAMC A23264, -29.3501°, 31.5835°, Prince's Grant, depth 57m, Natal Dredging Programme, 9 September 1964.	*Ophiothrix (Acanthophiothrix) proteus*
SAMC A23265, -31.2330°, 16.6001°, Gysobay, depth 272m, 15 August 1947.	*Ophiura (Ophiuroglypha) costata costata*
SAMC A23333, -33.8166°, 16.5000°, off Cape Town, depth 2730m, *Africana* II, station number A193, 27 August 1959.	*Ophiactis abyssicola*
SAMC A23341, -33.8116°, 16.5000°, off Cape Town, depth 2730m, *Africana* II, station number A193, 27 August 1959.	*Ophiura (Ophiuroglypha) irrorata irrorata*
SAMC A23344, -33.8166°, 16.5000°, off Cape Town, depth 2730m, *Africana* II, station number A193, 27 August 1959.	*Ophiura ljungmani*
SAMC A23378, -34.1250°, 18.5170°, Fishhoek, False Bay, depth 7-9m, UCT Ecological Survey Collection, station number FB1058E, 8 September 1946.	*Amphiura (Amphiura) incana*
SAMC A23823, -46.6834°, 37.9335°, off Marion Island, depth 138m, 15 September 1984.*	*Amphiura (Amphiura) angularis*
SAMC A28130, -27.5166°, 32.6833°, Sodwana Bay, depth 15m, J.L.B. Smith Institute, 25 July 1976.	*Ophiomastix koehleri*
SAMC A28132, -27.5166°; 32.6833°, Sodwana Bay, depth 15m, J.L.B. Smith Institute, 23 July 1976.	*Ophiarachna affinis*
SAMC A28143, -31.0000°, 30.4500°, off Glenmore, depth 900m, *Meiring Naude*, station number SM134, 12 May 1977.	*Asteroschema salix*
SAMC A6460, -35.1340°, 21.8810°, off Gouritz, depth 164-182m.	*Astrophiura permira*
SAMC A74041, -26.8669°, 32.9167°, NE of Kosi Bay, depth 49m, *Meiring Naude*, station number ZA41, 3 June 1990.	*Ophioconis cupida*
SAMC A74058, -27.5230°, 32.6920°, Sodwana Bay, depth 7.5m, ACEP II, 15 October 2010.	*Amphipholis similis*
SAMC A74065, -27.5230°, 32.6920°, Sodwana Bay, depth 7.5m, ACEP II, 15 October 2010.	*Ophiactis picteti*
SAMC A74078, -34.0817°, 23.0126°, Knysna, depth 0m, UCT Ecological Survey Collection, 7 July 1960.	*Amphioplus (Lymanella) depressus*
SAMC A7470, -35.3750°, 18.5160°, off Cape Point, depth 1638m.	*Ophiura flagellata*
SAMC A7475, -35.3750°, 18.5160°, off Cape Point, depth 910m.	*Ophiocten hastatum*
SAMC A7516, -33.7650°, 17.5160°, off Table Bay, depth 364m, 1 January 1922 (dorsal).	*Ophiothrix (Ophiothrix) aristulata*
SAMC A7519, -34.5020°, 18.4760°, off Cape Point, depth 155m.	*Astrothorax waitei*
SAMC A7536, no data available (ventral).	*Ophiothrix (Ophiothrix) aristulata*
SAMC A7539, No data available.	*Ophiernus vallincola*
SAMC A088402, -34.5176º, 25.4526º, off Port Elizabeth, depth unknown, 7 September 2008.	*Ophiocten affinis simulans*
Unknown, off Durban, depth 124m, *Pickle*, 29 August 1929, from Koehler (1905).	*Ophiogymna fulgens*
USNM 1072476, -29.4500º; 31.5100º, East of Durban, depth 68-70m, *Anton Bruun*, station number 394B, 25 September	*Astroglymma* cf. *sculptum*

1964.	
USNM E42847, -23.7500°, 43.1833°, Tolitary, Madagascar, depth 3027m, *Anton Bruun,* station number 363-D, 5 August 1964.*	*Amphiophiura sculptilis*
ZMB 1623/1936 (538/1), -35.4833°, 21.0333°, Agulhas Bank, depth 86m, *Valdivia,* station number 105, syntype, from Clark and Courtman-Stock (1976)	*Ophiochasma nitida*
ZMUC OPH-126, -29.9330°, 31.3250°, off Durban, depth 412m, 26 August 1929.	*Ophioscolex inermis*
ZMUC OPH-190, 30.0666°, 31.0000°, off Durban, depth 91m, 27 August 1929, syntype.	*Amphiura (Amphiura) linearis*
ZMUC OPH-210, Anstey's Beach, -29.9300°, 31.3200°, depth 411m, 26 August 1929.	*Amphiura (Amphiura) grandisquama natalensis*
ZMUC OPH-216, Norway, depth 200m, July 1911, syntype.*	*Ophiactis nidarosiensis*
ZMUC OPH-263, off Durban, -29.8100°, 31.3000°, depth 219m, 22 August 1929.	*Ophiacantha scutigera*
ZMUC OPH-278, -33.2833°, 27.5833°, Buffalo River mouth, depth 44m.	*Ophioplinthaca sexradia*
ZMUC OPH-284, -29.9300°, 31.3200°, Anstey's Beach, depth 411m, 29 August 1929.	*Ophiolycus dentatus*
ZMUC OPH-288, -32.7450°, 28.5140°, north east of East London, depth 174m, *Pieter Faure*, station number P.F.13476, holotype.	*Ophiomyxa tenuispina*
ZMUC OPH-307, -29.8696°, 31.0561°, off Durban, depth 382m, holotype.	*Asterostegus tuberculatus*
ZMUC OPH-318, Cannoniers Point, Mauritius, depth unknown, October 1929.*	*Ophionereis vivipara*
ZMUC OPH-362, -29.8770°, 31.1940°, off Durban, depth 411m, 26 August 1929, *Pickle,* syntype.	*Amphioplus (Unioplus) falcatus*
ZMUC OPH-478, type locality 'Cap', (from Mortensen 1933), syntype.	*Ophiogymna capensis*
ZMUC OPH-74, South Africa, 1 November 1930, holotype.	*Astrocladus africanus*